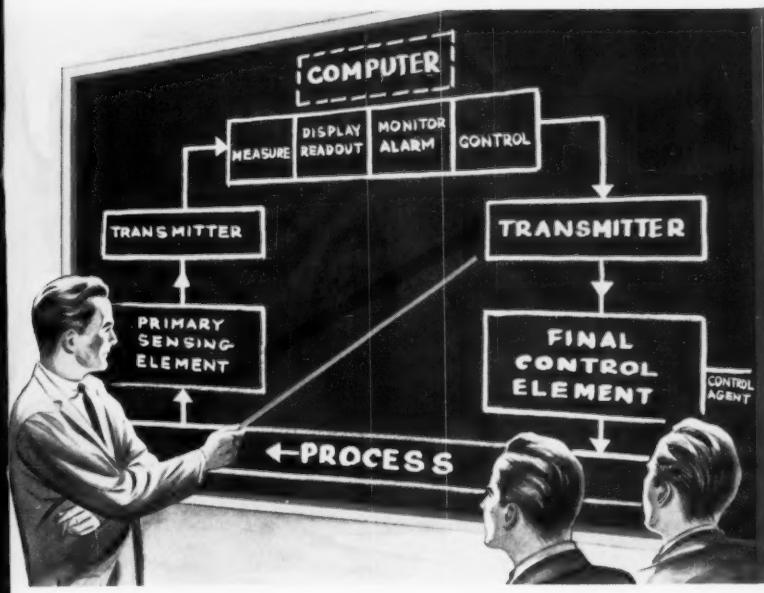
A McGRAW-HILL PUBLICATION **SEPTEMBER 1961**

ONE DOLLAR

Power

the magazine of energy systems engineering



Where to send men for training in instrumentation and process control

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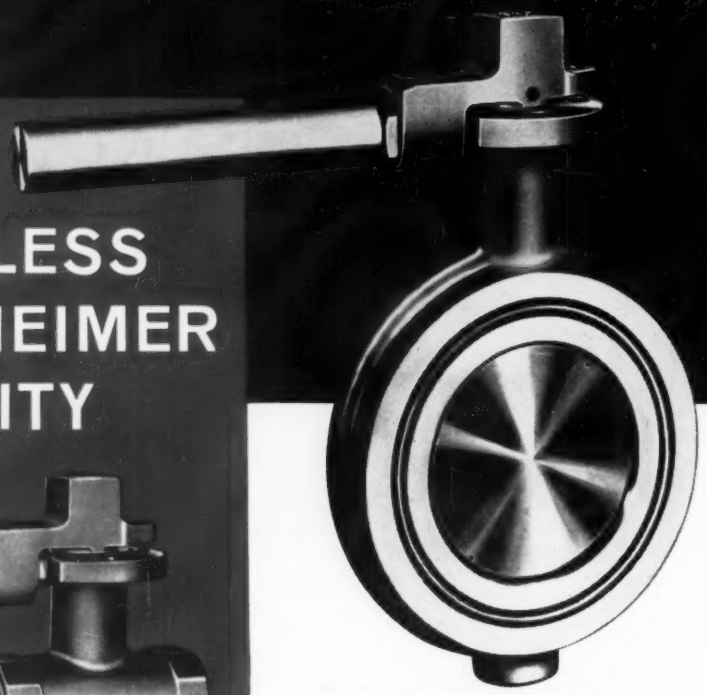
NEW Butterfly Valve!



MATCHLESS LUNKENHEIMER QUALITY

FIG. 4026N
Complete Valve with Ends on Casting.
2"-6".
Screwed End.

FIG. 4150N
(Rubber-Lined: Fig. 4151R) Valve Elements Only.
2"-18". Screwed, Welded, Grooved, or Flanged Ends Supplied Separately to Fit Your Pipe Connections.

W. P. 150 psi.

- QUICK OPENING
- POSITIVE CLOSURE
- NICKEL-PLATED CAST IRON
- STAINLESS STEEL TRIM
- "O" RING SEALS

New Lunkenheimer Butterfly Valves are compact and lightweight, easy to install on any line in a fraction of the space required by standard gate or plug valves. A quarter-turn of the stem opens the disc full or closes it tight. No lubrication is required, and "O" Ring seals provide positive shut-off in either vacuum or pressure service. These new Butterfly Valves are made to traditional Lunkenheimer standards of quality. WRITE for new Catalog 613 or call your Lunkenheimer distributor today for full information on the new Lunkenheimer Butterfly Valve line . . . available now for immediate delivery.

L-361-23

LUNKENHEIMER®
THE ONE Great NAME IN VALVES

For more facts circle 201 on Reader Service card, p 109

Super Filmeen® reduces tube failure by 85% for big Eastern utility

THE PROBLEM: Severe corrosion of feedwater heater tubes, particularly in plants operating on peak loads. In just one such plant, 325 tubes failed in 1959.

THE CAUSE: Oxygen inleakage during idle periods resulted in a free oxygen content as high as 6.5 ppm at startup and 0.10 ppm even after several hours of operation. Other contributing factors were small amounts of ammonia and carbon dioxide.

THE SOLUTION: Dearborn engineers recommended patented Super Filmeen, the most advanced form of filming amine now available, to be applied to the system by injection into the feed water.

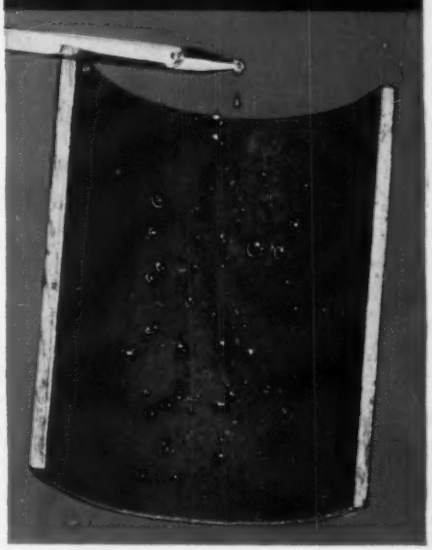
THE RESULTS: 85% reduction in tube failure within a few months with the rate of failure still decreasing. Reduction or elimination of periodic acid cleaning of boilers is likely since the cleaning action of Super Filmeen has removed past corrosion deposits and new corrosion is greatly reduced.

The non-wettable film characteristic of Super Filmeen, extending progressively in the system, has provided protection throughout the plant.

Admiralty tubes, rid of corrosion products and provided with this film, now show a pewter-like luster.

Why not add your plant to the growing list of those which are finding Super Filmeen the complete answer to stubborn corrosion problems? Call your Dearborn representative. Or write today for technical details.

Super Filmeen forms a non-wettable, monomolecular, corrosion inhibiting film. Note how water remains in droplets which roll off a Super Filmeen treated pipe surface.



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For more facts circle 204 on Reader Service card, p 109

speaking of **Power**

Approaching their 5th anniversary, the Foundation for Instrumentation Education and Research (FIER) can take justifiable pride in their steps to date toward a lofty goal: encouragement of better understanding and further progress in instrumentation and related fields.

During the early years, FIER has nurtured projects specifically aimed toward attracting gifted students and teachers into study and research in instrumentation, encouraged industry to further new and promising uses for instrumentation technology. By 1959 somewhat of a pattern had emerged, with FIER activities resolving into the important areas of student fellowships, teacher education, technical clinics. During 1960 the Foundation added some modest research grants, plus a project for bringing teachers into industry to study.

Latter step was taken in view of the fact that few college teachers are given the opportunity to really keep abreast of on-the-job developments in the technology of instrumentation. This is particularly true for senior faculty people whose commitments make it difficult for them to break away from campus to accept a summer job in industry. FIER's in-industry scholarships for college professors grant a 1-month exposure to modern instrumentation in a modern industrial climate.

This important work of training teachers-in-industry, carried out under the guidance of FIER's Executive Director, Lloyd Slater, helps point up another growing area of need: training for men-in-industry.

Recognizing this need, POWER's Associate Editor Steve Elonka surveyed schools and industry to seek out educational opportunities in instrumentation and control for plant people. His findings, organized and developed with Lloyd Slater's help, are published in this issue starting on p 69. Use this survey to guide your selection of a training site for men earmarked for development in the field of instrumentation.

Lou Rowley

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Print order this issue: 50,204

POWER (with which are consolidated *Science and Industry, The Engineer Review, The Engineer, The Stationary Engineer* and *Operating Engineer*) is published monthly by McGraw-Hill Publishing Company, Inc, James H McGraw (1860-1948), Founder. PUBLICATION OFFICE: McGRAW-HILL BUILDING, 330 W 42nd St, New York 36, N. Y. See box, right, for directions regarding subscriptions or change of address. EXECUTIVE, EDITORIAL, CIRCULATION and ADVERTISING OFFICES: 330 W 42nd St, New York 36, N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L Bond, President; Shelton Fisher, Wallace F Traendly, Senior Vice-Presidents; John R Callaham, Vice-President and Editorial Director; Joseph H Allen, Vice-President and Director of Advertising Sales; A R Venezian, Vice-President and Circulation Coordinator. OFFICERS OF THE CORPORATION: Donald C McGraw, President; Joseph A Gerardi, Hugh J Kelly, Harry L Waddell, Executive Vice-Presidents; L Keith Goodrich, Vice-President and Treasurer; John J Cooke, Secretary.

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United States subscription rate for individuals in the field of the publication $3.00 per year, single copies $1.00, unless otherwise indicated. Canada; $5.00 for one year. Foreign; $15.00 for one year. Second-class

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Power articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own annual index, obtainable on request to the Editor. Notice of availability appears in POWER.

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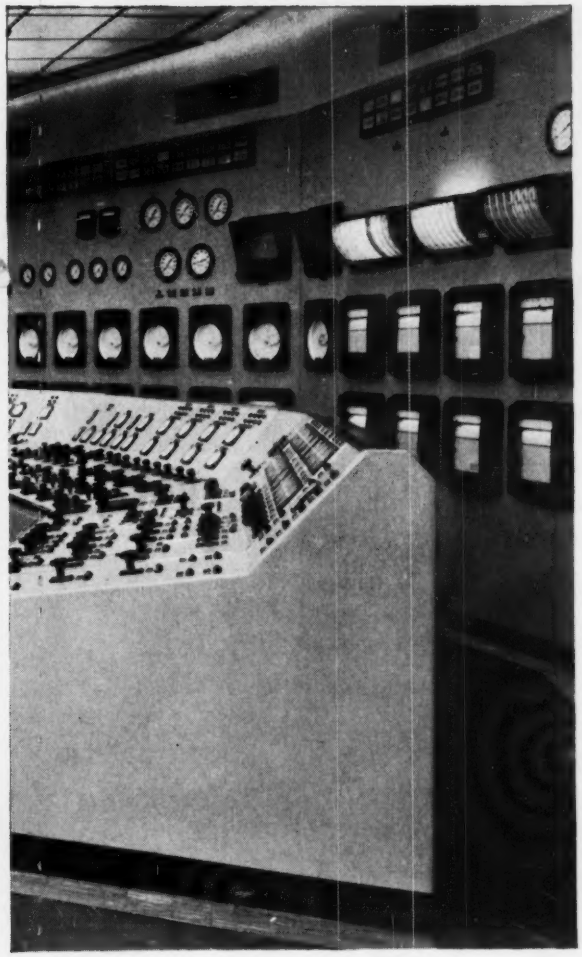
IT'S BAILEY FOR AMERICA'S

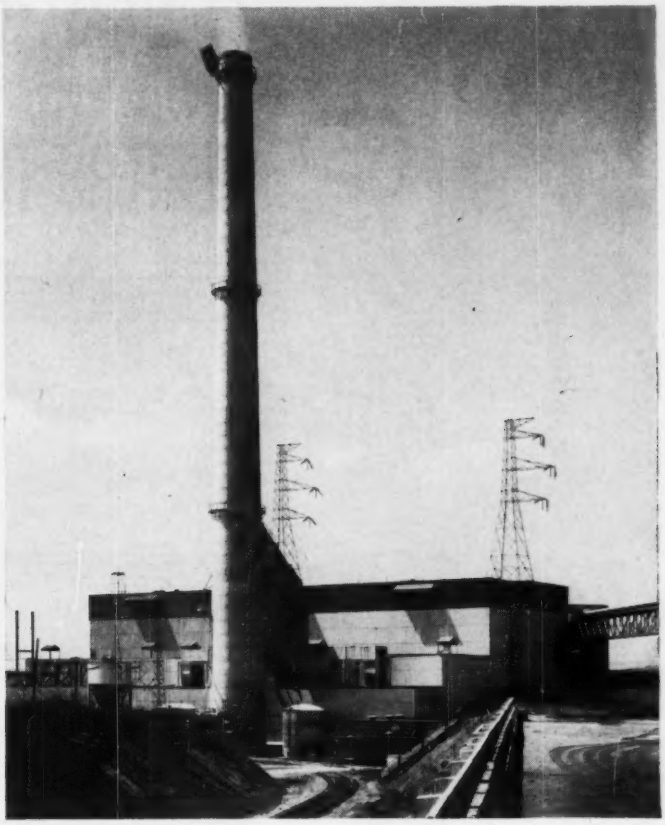
1959 STEAM-ELECTRIC PLANT HEAT RATES FROM FEDERAL POWER COMMISSION REPORT S-143

	Btu/kw-hr	Meters	Combustion Control	Feed Water Control	Superheat Control
1. Dickerson (Potomac Electric Power Co.)	9,007	B	B	B	B
2. Clinch River (Appalachian Power Co.)	9,011	B	—	B	B
3. Kanawha River (Appalachian Power Co.)	9,098	B	B	B	B
4. Silas McMeekin (South Carolina Electric & Gas)	9,130	—	—	—	—
5. Muskingum River (Ohio Power Co.)	9,170	B	B	B	B
6. River Rouge (The Detroit Edison Co.)	9,170	—	—	—	—
7. Clifty Creek (Indiana-Kentucky Electric Corp.)	9,173	B	B	B	B
8. G. G. Allen (Duke Power Co.)	9,174	B	B	B	B
9. Tanners Creek (Indiana & Michigan Electric Co.)	9,176	B	B	B	B
10. Shawville (Pennsylvania Electric Co.)	9,179	B	—	—	B
11. Kammer (Ohio Power Co.)	9,203	B	B	B	B
12. St. Clair (The Detroit Edison Co.)	9,250	B	B	B	B
13. Kyger Creek (Ohio Valley Electric Corp.)	9,284	B	—	B	B
14. Portland (Metropolitan Edison Co.)	9,322	—	—	—	—
15. Oak Creek (Wisconsin Electric Power Co.)	9,336	B	B	B	B
16. Bayshore (Toledo Edison Co.)	9,365	B	B	B	B
17. Milliken (N. Y. State Electric & Gas Corp.)	9,374	B	—	B	—
18. Philip Sporn (Appalachian Power Co.)	9,381	B	B	B	B
19. John Sevier (Tennessee Valley Authority)	9,390	—	—	—	—
20. Mandalay Beach (Southern California Edison Co.)	9,397	B	B	B	B
21. Gallatin (Tennessee Valley Authority)	9,420	—	—	—	—
22. Huntington (Southern California Edison Co.)	9,436	B	B	B	B
23. Colbert (Tennessee Valley Authority)	9,460	B	B	B	B
24. Will County (Commonwealth Edison Co.)	9,460	B	—	B	B
25. Agua Fria (Salt River Project A.I.F. Dist.)	9,473	B	B	B	B
26. Salem Harbor (New England Power Co.)	9,485	B	B	B	B

***per 1959 Heat Rates reported by FPC**



Bailey Controls for combustion, feed water and steam temperatures at the Dickerson Generating Station of Potomac Electric Power Co. The Federal Power Commission reported a 1959 heat rate of 9007 Btu per kw-hr, ranking it as No. 1 plant in efficiency in the United States.



NO. 1* STEAM PLANT

and for 20 out of the next 25 "most efficient" plants, too

Most efficient power plant in 1959, as rated by the Federal Power Commission, was Dickerson Station of Potomac Electric Power Co. And for measuring and controlling functions that helped attain this record, Dickerson relies on Bailey Meters and Controls.

Moreover, *in 21 out of all 26* "most efficient" plants, with heat rates under 9500 Btu per kw-hr, Bailey Meters and Controls are used for some or all functions.

Why? The reasons aren't hard to find. Bailey engineers have worked hand-in-hand with leading power engineers for more than 45 years to advance steam-plant efficiency rates . . . have pioneered the research and development of improved measurement and control techniques that have produced much of today's high reliability of steam-plant operation . . . have simplified and verified instrumentation and control systems to the point where automation can be approached confidently.

And now, working to extend the benefits of automation over the full range of plant operations, Bailey offers systems incorporating advanced techniques for scanning, alarming, logging, computing, digital logic and sequencing . . . all co-ordinated with established analog equipment to provide maximum safety, economy and reliability . . . all compatible with the needs of power management, technical and nontechnical.

Ask your nearby Bailey District Office or Resident Engineer how new Bailey concepts and advanced systems techniques may be applied to your operations.

A-164-2

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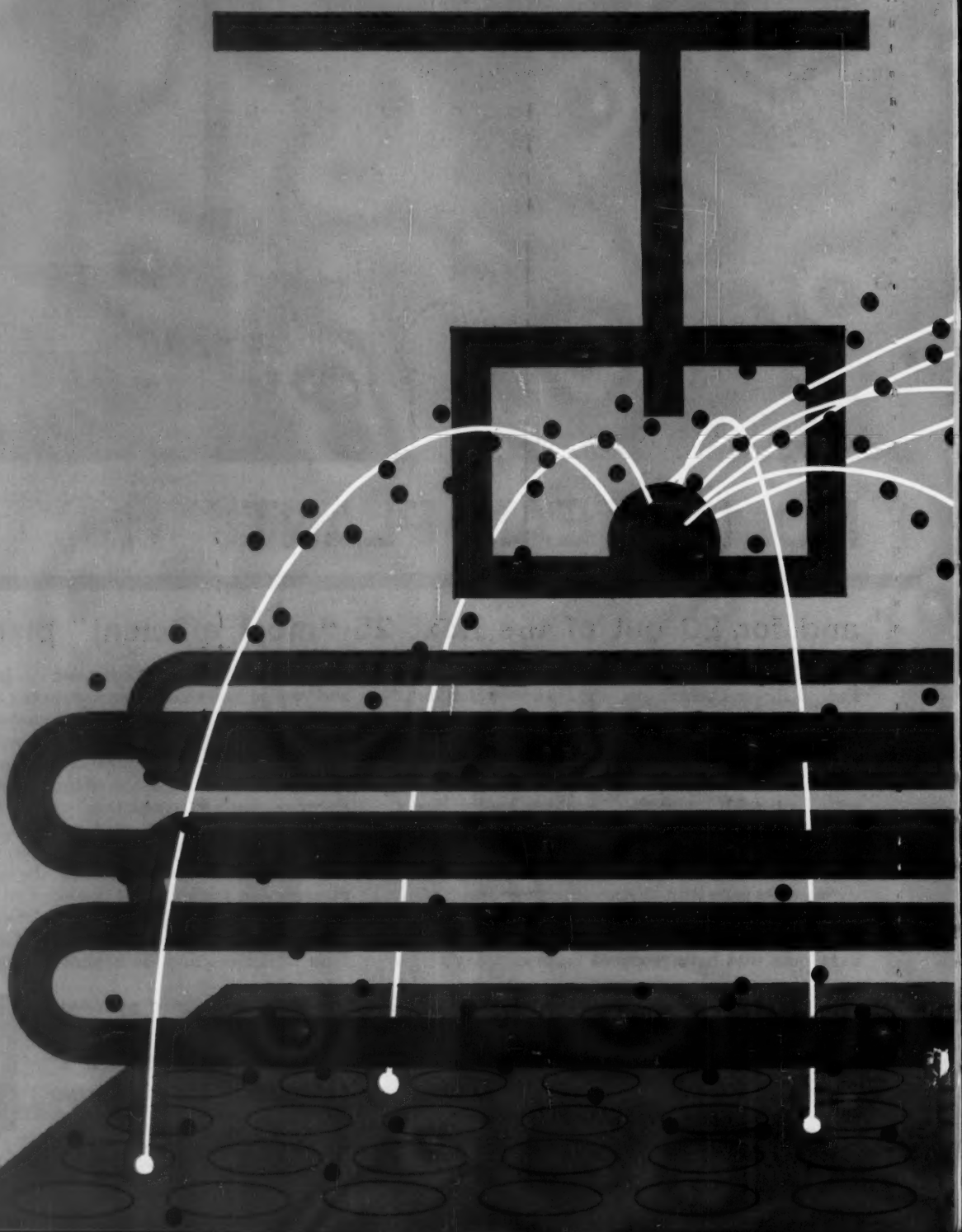
BAILEY METERS

For more facts circle 205 on Reader Service card, p 109

Circle 206 on Reader Service card for following ad ➤

Diamond developed for more economical power...

PENNSYLVANIA ELECTRIC SELECTS DIAMOND SHOT CLEANING FOR AIR HEATERS THAT WON'T STAY CLEAN!



To maintain constantly clean airheaters, thereby minimizing draft losses and reducing annual outage time, Pennsylvania Electric Company is installing Diamond Shot Cleaning Systems on Shawville Station Steam Generating Units No. 1 and 2. Because Diamond Shot Cleaning Systems consistently have proved to be highly effective for this difficult cleaning application, Pennsylvania Electric anticipates significant savings through elimination of unpleasant manual cleaning and the costly boiler downtime that goes with it.

The selection of Diamond Shot Cleaning is typical of Pennsylvania Electric's continuing effort to achieve greater power generating efficiency. It also demonstrates the growing acceptance of a totally new concept in cleaning waste heat, recovery, and power boilers that defy cleaning by conventional methods. At your request, our engineers will be happy to discuss the application of Diamond Shot Cleaning to your new or existing steam generator. Call, write or wire.

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This is the new trademark of Diamond Power ... a symbol of quality, integrity and progress ... in products, systems and service.

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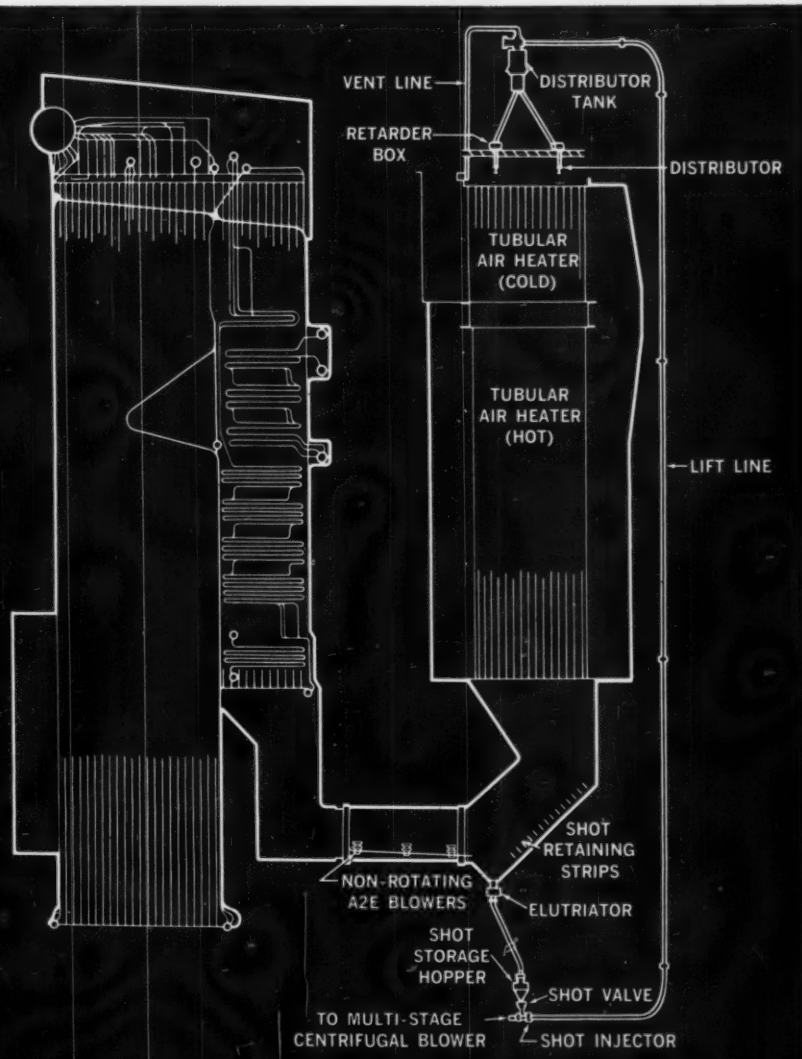

General arrangement of Diamond Shot Cleaning System now being installed on Penna. Electric's Shawville Station Steam Generating Units No. 1 and 2. System has 135 foot lift system . . . highest installation yet using standard equipment.

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VIRGINIA ELECTRIC & POWER
IOWA ELECTRIC LIGHT & POWER
NEBRASKA POWER
NEW ENGLAND POWER
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POTOMAC ELECTRIC POWER CO.
PACIFIC GAS & ELECTRIC

WATER LEVEL INDICATION ?

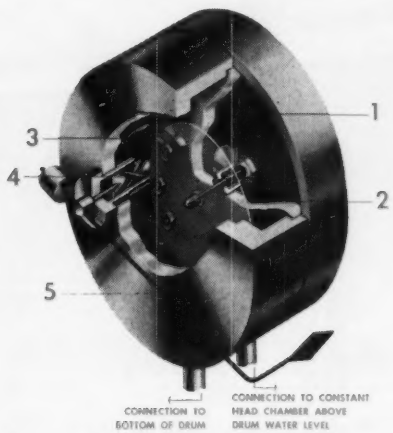
YARWAY REMOTE INDICATORS HAVE BRILLIANT "WIDE ANGLE" VISIBILITY... CAN BE INSTANTLY READ FROM MULTIPLE VANTAGE POINTS

Yarway Remote Liquid Level Indicators bring distant, often hard-to-see boiler level readings right down to eye level on the panel board or other convenient location.

No matter where you stand—at any point in a 180° arc, and from a considerable distance—the brilliant new wide vision dial makes viewing and reading easy.

GIVE INSTANT, ACCURATE READINGS BECAUSE INDICATOR IS OPERATED BY THE BOILER WATER ITSELF

Remote readings of levels in boilers (also feed water heaters and other heat exchangers) are instant and accurate because indicator *operating mechanism* is actuated by the varying head of the liquid itself, yet the *pointer mechanism* is never under pressure.



Constant pressure from a controlled-temperature constant head chamber located above drum level is maintained on one side of diaphragm (1) in indicator. Varying pressure changing with water level is maintained on opposite side of diaphragm. Change in differential between the two pressures moves the diaphragm which in turn regulates, through deflection plate (2), magnet (3), and spiral magnetic armature (4), the position of the counterbalanced pointer (5).

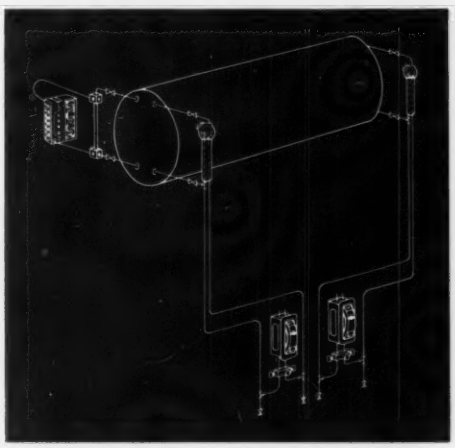
OPERATE ADDITIONAL REMOTE SIGNAL ALARMS, HORNS OR LIGHTS

With the addition of a control unit Yarway Indicators may be equipped to operate auxiliary hi-lo signal alarms, horns or lights located at any place in the plant. Electronic secondary indicators may also be used to duplicate readings at remote points.

FULLY APPROVED AS PRIMARY INDICATING ELEMENTS UNDER BOILER CODE CASE #1155

Under A.S.M.E. Boiler Code Committee ruling in Case #1155, two independent remote level indicators of compensated manometric type may be used instead of one of two required gage glasses for boiler pressures 900 psi and above. When both indicators are in operation, the gage glass may be shut off but shall be maintained in serviceable condition.

Yarway Remote Liquid Level Indicators conform to this ruling and are used widely for primary boiler water level indication in plants operating at 900 psi and above



All Yarway Indicators for service over 700 psi are temperature-compensated; pressure compensation available when desired. Use of controlled-temperature column on constant head chamber fully protects against system upsets.

If you would like a reprint of this Boiler Code ruling, just ask for Case #1155 reprint.

Get the full story on Yarway Liquid Level Indication for your plant. Write for new 24-page Bulletin RI-1825.

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For more facts circle 207 on Reader Service card, p 109

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PHELPS DODGE!

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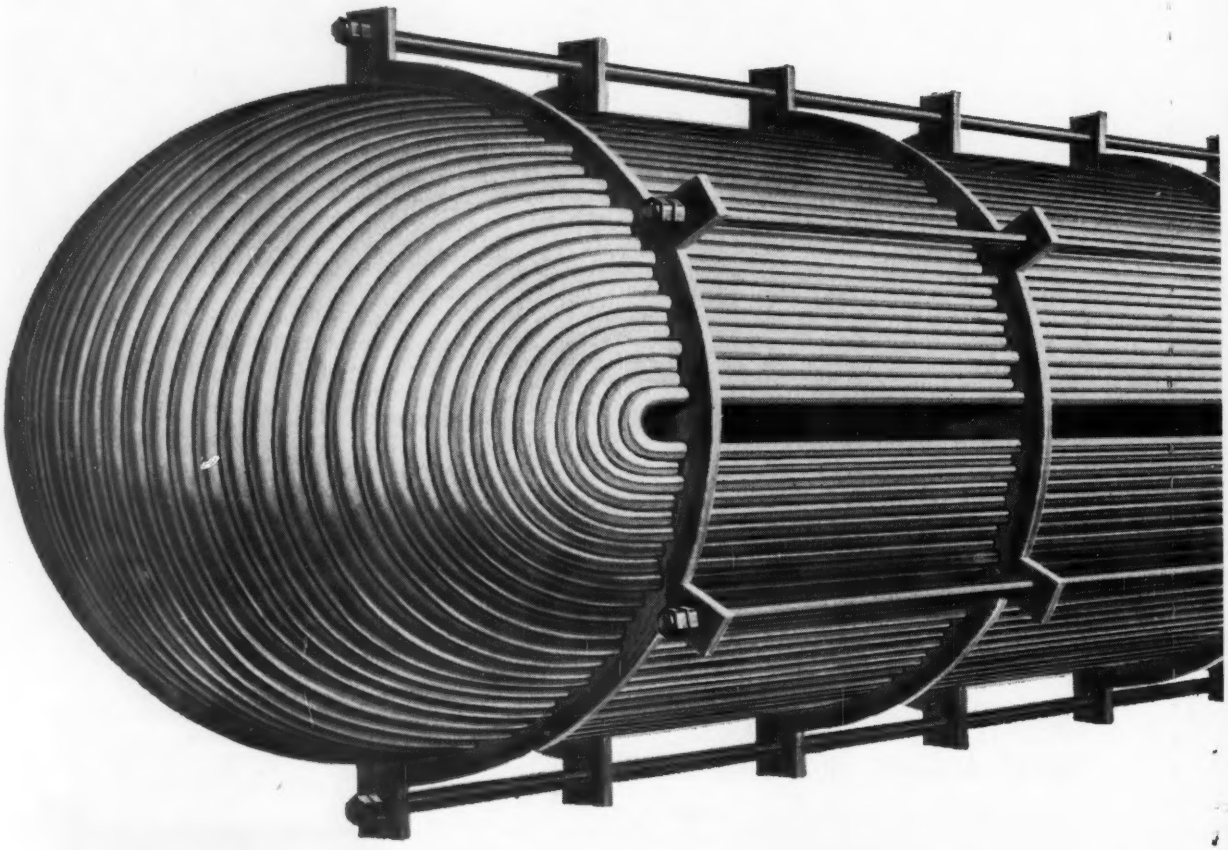


In August 1959, Phelps Dodge introduced the first high strength copper-nickel alloy condenser tube, Cufenloy-30. Now Phelps Dodge offers Cufenloy-40, a copper-nickel alloy with greatly increased strength suitable for the most severe applications in high pressure feedwater heaters. The mechanical and physical properties of this exclusive new alloy make possible substantial reductions in the cost of feedwater heaters. Cufenloy-40 has received approval for ASME Code applications through Case 1300 (Special Ruling).

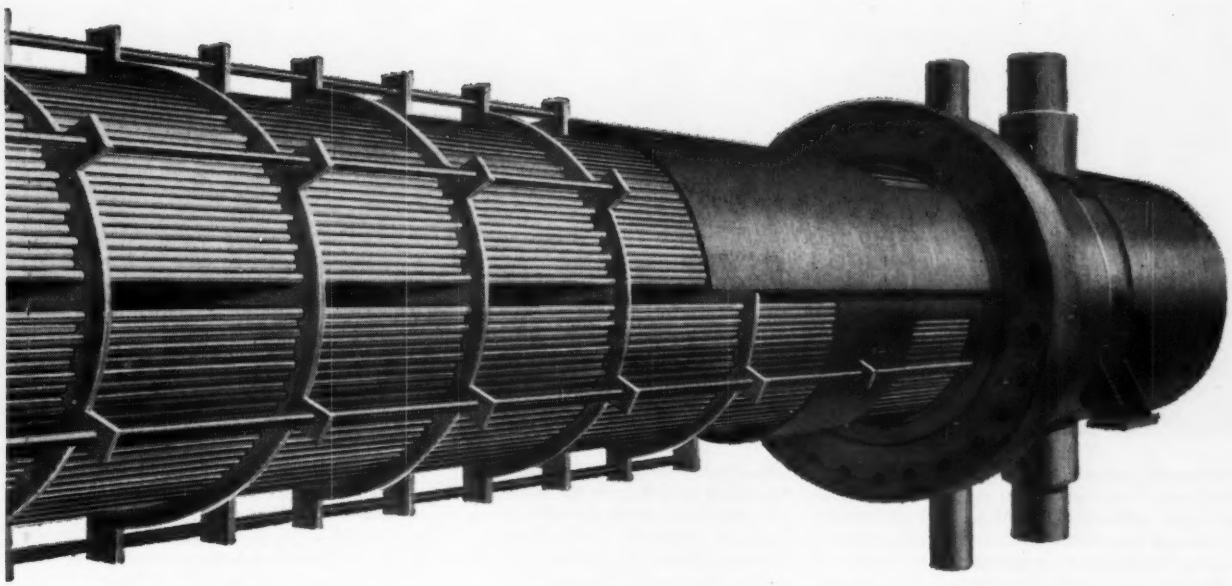
Weldability. Extensive tests in Phelps Dodge's laboratories were performed to determine Cufenloy-40's welding characteristics. Standard welding procedures used for 70/30 copper nickel tubes were found to be fully acceptable for this new composition. Pull-out, Cycling and Pressure Tests confirmed that a maximum joint efficiency was obtained using these procedures.

Corrosion Resistance. Corrosion studies have been performed on Cufenloy-40 since 1959 and have shown it to be unsusceptible to stress corrosion cracking in a moist ammonia and carbon dioxide atmosphere. In these tests Cufenloy-40 also proved virtually immune to general chemical attack. It is believed that Cufenloy-40 has the best overall corrosion resistance of the copper-nickel alloys.

Dual Gauge. Cufenloy-40 condenser tubes are available in dual gauges wherever a thickened wall section is needed to compensate for thinning on tight radius bends.

U-Bent Tubes. Cufenloy-40 tubes are also furnished in factory "U" bends for immediate tubing into the unit at the manufacturer's plant or on the job site.

Further Information from your local Phelps Dodge sales office, or write Dept. 2A for the Cufenloy-40 technical brochure.



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MINE TO MARKET
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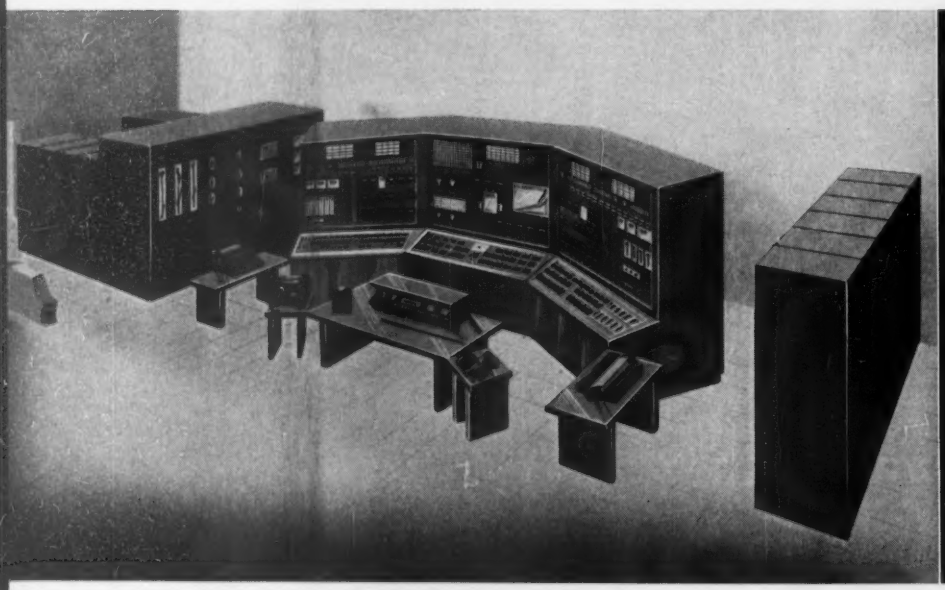
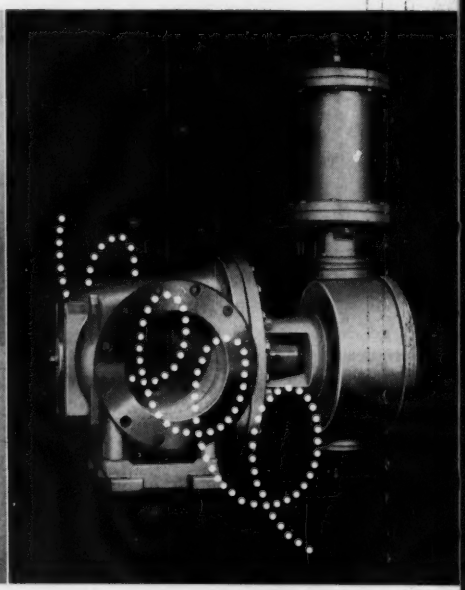
For more facts circle 208 on Reader Service card, p 109

Current news reports

WHAT'S HAPPENING IN POWER SERVICES?

Highlights: A high voltage control center that requires half as much floor space. Smaller power transformers with considerably more kva capacity. These examples demonstrate the extra value that is standard with Allis-Chalmers . . . the greater efficiency and the added productivity that are yours when you buy A-C products, systems and services. Call your nearby Allis-Chalmers office for details or write Allis-Chalmers, Industries Group, Milwaukee 1, Wisconsin.

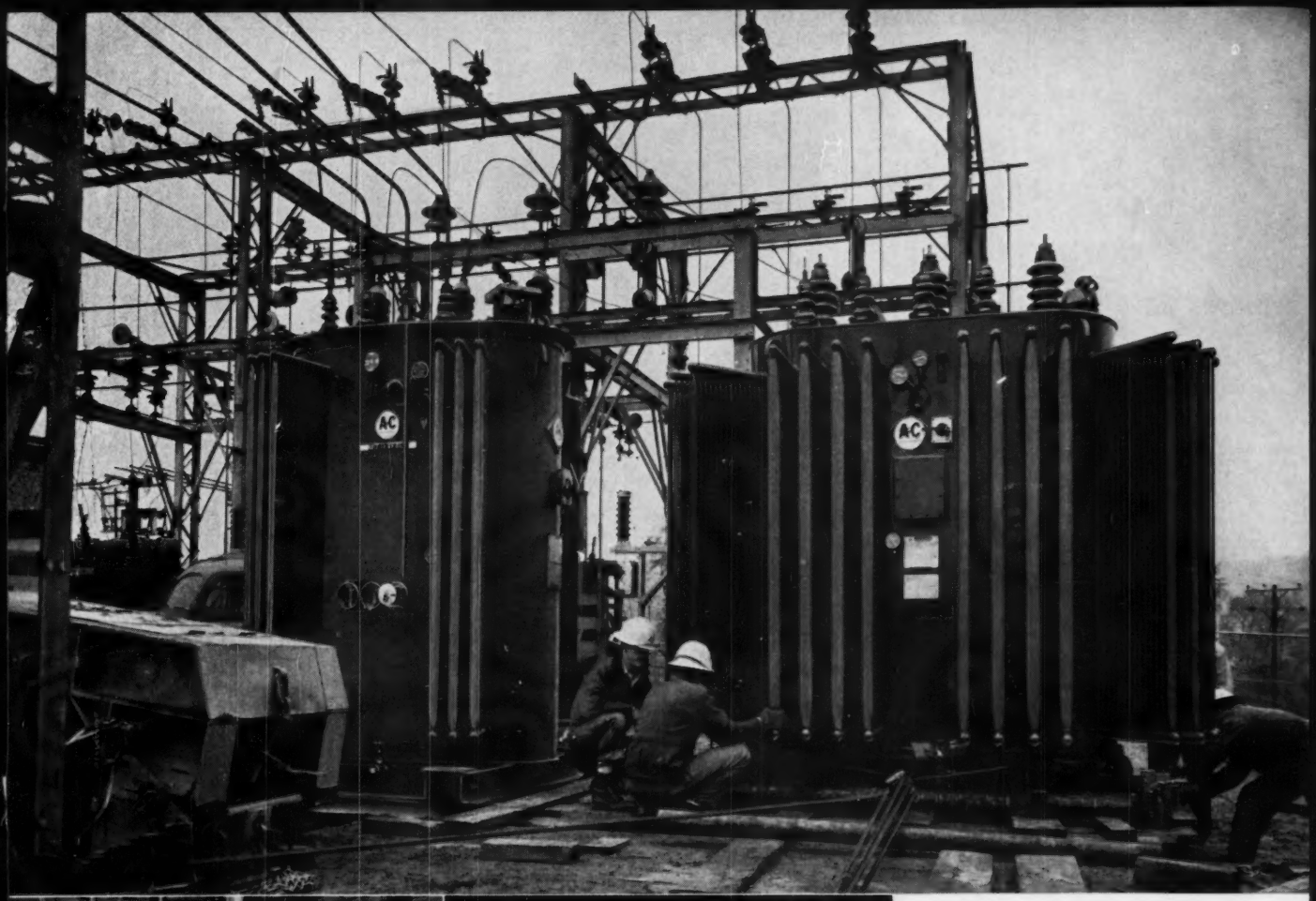


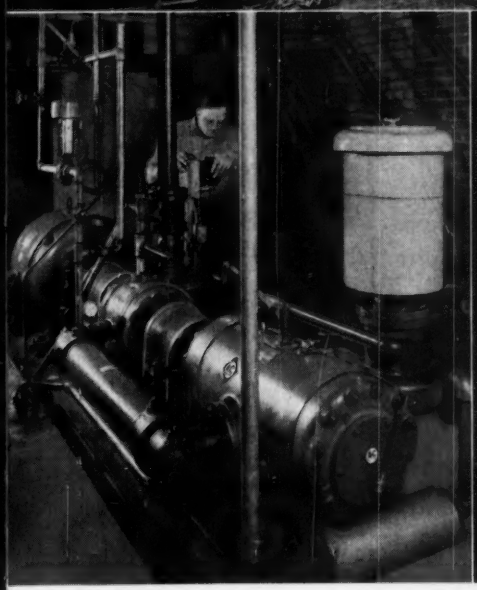


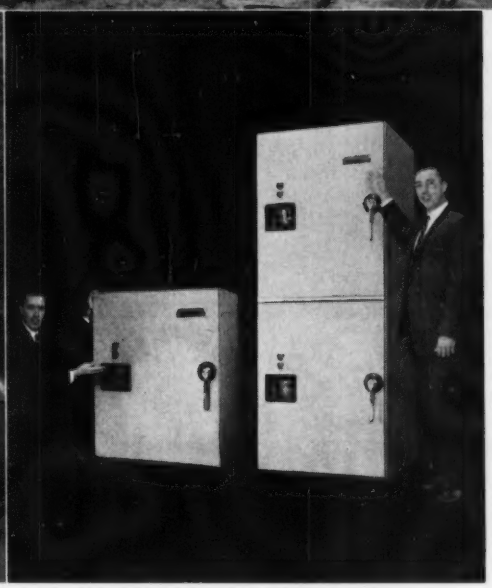
For quality control . . . lower power costs: With the acquisition of Consolidated Systems Corporation last year, Allis-Chalmers extended its ability in the areas of data gathering, handling and utilization. CSC provides such experience acquired from more than 500 successful system projects. Recently, Allis-Chalmers, Consolidated Systems and International Business Machines Corporation effected a nonexclusive mutual agreement relating to the production and marketing of automated control systems.

For the typical system, A-C takes functional responsibility for the system using IBM data processing computer equipment, CSC specially engineered data conditioning equipment, instrumentation, and A-C power and industrial processing equipment. Now, Allis-Chalmers brings balance of specialized judgments to bear on your problems . . . drawn on significant experience . . . to make major "contributions to the art" in many phases of *Systemation* and help you be sure before you invest.

"Open road" for unrestricted flow: This *Rotovalve*, when wide open, offers no greater resistance to flow than a straight pipe of equivalent length. Promotes lower pumping costs. Actually seats itself tighter with use. And special shutoff characteristics reduce water hammer. All moving parts are totally enclosed, yet easily accessible.







Transformers "grow up" but don't get bigger: New Allis-Chalmers transformers deliver as much as a 30% increase in kva without any increase in size or weight. This permits replacement of old transformers without altering base mountings or overhead structures. This unit being installed has twice the rating of the neighboring 3500-kva transformer.

More air . . . less wear, with vibration-free compressors: *Ro-Flo* compressors with sliding-vane rotary design eliminate operating losses inherent in reciprocating machines. Centrifugal force keeps vanes in close contact with cylinder walls, automatically compensating for wear. In addition, fewer moving parts result in less wear, reduced maintenance costs.

So low, two fit where one used to go: This new *SpaceMaker* control center is the first completely new 2- to 5-kv motor controller development in more than a decade. New, compact two-high design can cut floor space requirements in half. Complete drawout construction makes it the safest, most easily accessible controller on the market. New flame-retardent, track-resistant Super *Pyro-Shield* insulation adds to reliability, reduces size and weight.

A-1522

SpaceMaker, Pyro-Shield, Ro-Flo and *Rotovalve* are Allis-Chalmers trademarks. *Systemation* is an Allis-Chalmers servicemark.

ALLIS-CHALMERS

For more facts circle 209 on Reader Service card, p 109

Selective-Sequence Controller

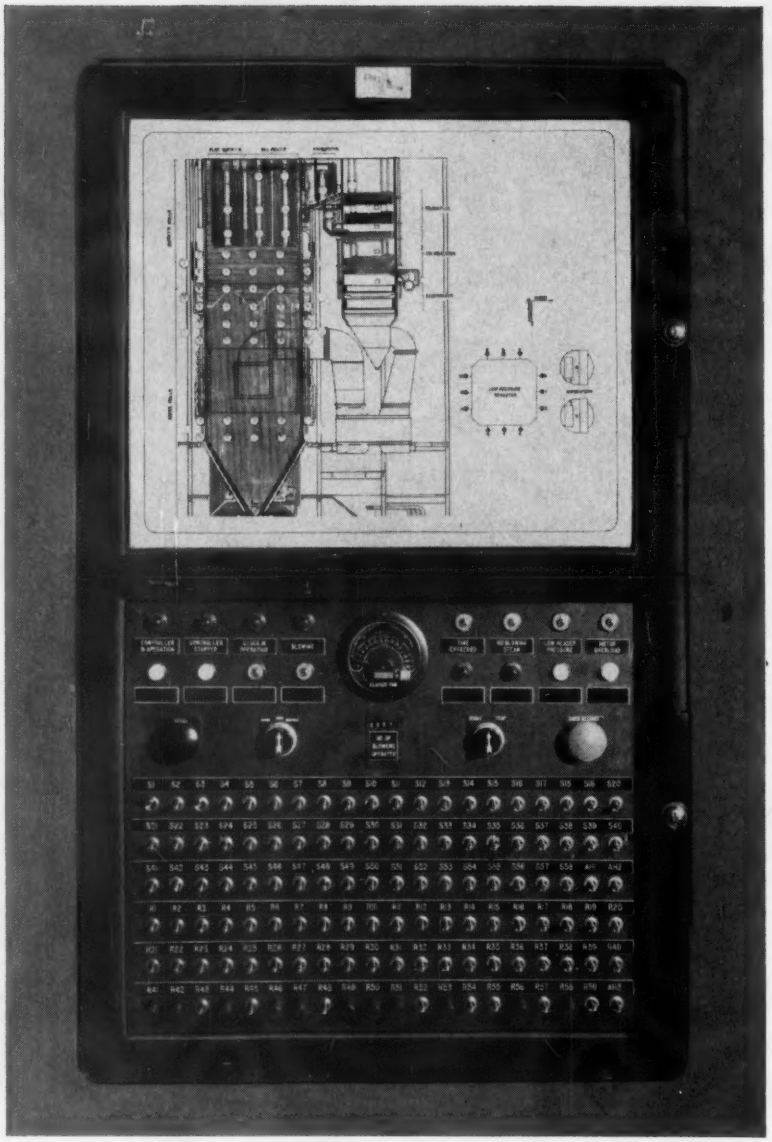
Up to 120 electrically-driven long retractable Vulcan soot blowers can be controlled by this SSC-120 controller. With it the operator can monitor the complete blowing program and get an instant report should there be any malfunction. In such case, interlocks automatically stop the blowing until a correction is made.

Vulcan Selective-Sequence control offers the greatest flexibility in automatic soot blowing. It permits varying the sequence by individual blowers — at any time, and in any way found desirable to improve boiler cleaning or to save blowing medium. Tied to a built-in clock, it permits 24-hour scheduling with three or more sequences.

Vulcan Automatic-Sequential Control permits the operator to pre-select any number of units to be operated individually — not necessarily by zones or bands. Without leaving the panel he can revise the sequence at any time, or switch instantly to single-unit operation.

Both control systems are described in Bulletin 1029. Write for it.

With either system: A new console-mounted miniature panel provides even greater convenience and efficiency. Soot blowing may be tied to some such phase of boiler operation as steam temperature control, a refinement with which Vulcan has had more than six years of experience. And for the ultimate in soot blower control, the Vulcan system can be tied in with computer operation of the plant.



Vulcan "Automated" Soot Blowing

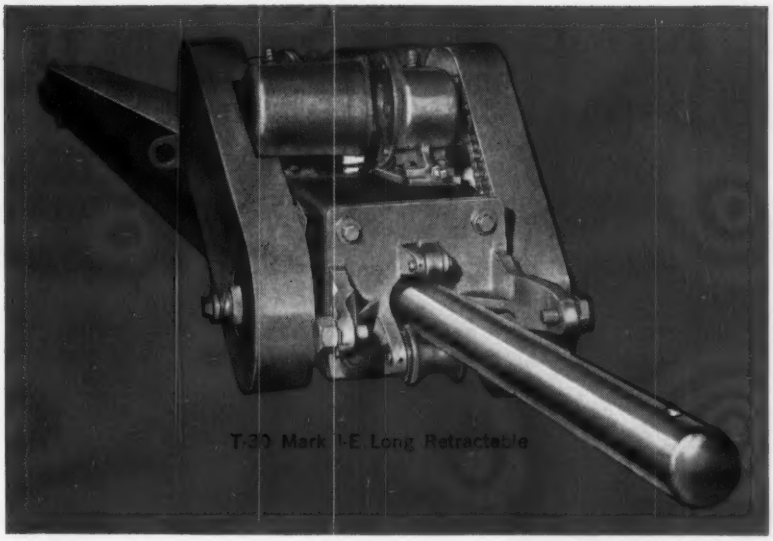
Modern boilers must be kept clean to operate efficiently—but the cleaning itself must be done efficiently to match modern operating procedures.

Vulcan precisely-controlled automatic soot blowing systems meet this specification.

They save time. One blower automatically follows another as programmed. Indexing is a matter of seconds.

They save labor. Merely pushing a button starts automatic operation. The operator or computer controls the whole system from one central location.

They save fuel. Cleaning is better because operation is positive and at proper intervals. Steam—which means fuel—and air are saved because of precise timing.



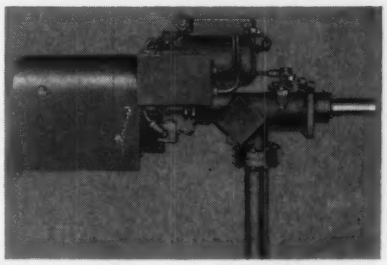
Vulcan RW-3E Wall Deslagger

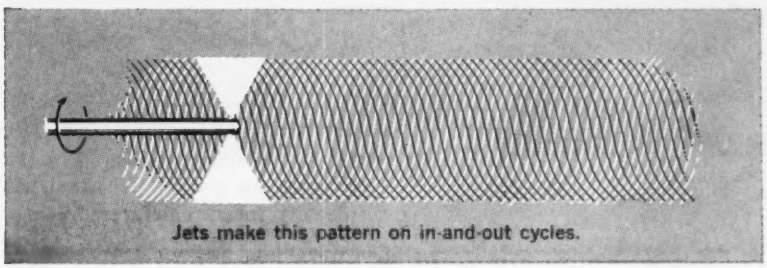
The high striking power of this electrically-operated deslagger drives off gummy, clinging masses or sintered ash to minimize average slag thickness. One motor extends and retracts the lance almost instantly. The other motor rotates the lance slowly for optimum cleaning. Air, saturated or superheated steam, or water—or any combination—can be used as the blowing medium. Blowing pressure may be adjusted while blowing. Maintenance is easy. Write for Bulletin 1034. Model RW-3A is air-driven. Write for Bulletin 1066.

Long Retractable Soot Blowers

The electrically-driven T-30 Mark I-E is the most modern long retractable soot blower for travels up to 24 feet. It has dual-motor drive. One motor moves the lance in and out. This can be a 2-speed motor to save blowing medium. The other rotates the lance—always in the same direction. The special-alloy lance can be used in almost any temperature. Low rotating speed increases range and penetration of cleaning, decreases wear, and eliminates whip. Write for Bulletin 1063. The T-30 Mark I-A, Bulletin 1073, is air-driven. For travels greater than 24 feet, the Vulcan T-30, Bulletin 1030, is used.

Rotary Soot Blowers with electric, air or manual operation are available for use in lower-temperature zones. Write for Bulletin 1072.




Jets make this pattern on in-and-out cycles.

Multi-Helix Jet Path

Because Vulcan long retractables have dual-motor drive, lance rotation is continuous with no stop-step action at the end of travel. The two jets always follow a different path in and out, forming an infinite number of reversed-helix paths on repeated cycles. This means thorough cleaning of all heating surfaces, minimized danger of tube erosion, and prolonged packing life.

saves time, saves labor, saves fuel

And maintenance is low. Each component of a Vulcan system is designed with maintenance men in mind.

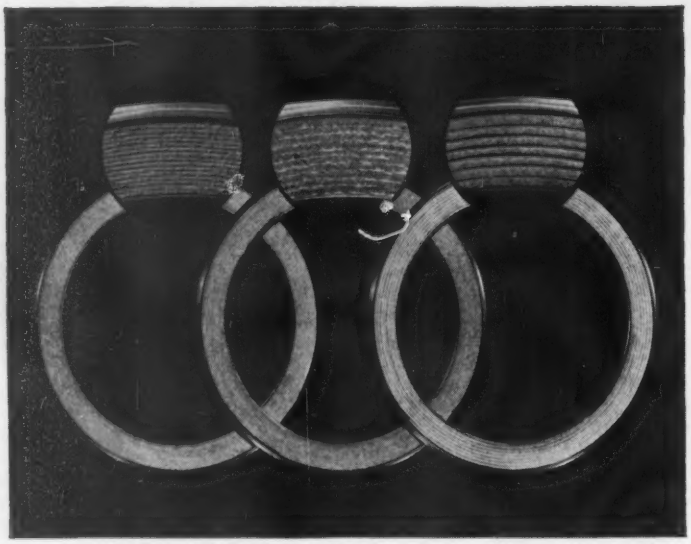
Write for the bulletins mentioned on these pages. Copes-Vulcan Division, Erie 4, Pennsylvania.

Copes-Vulcan Division
BLAW-KNOX

BLAW-KNOX

Blaw-Knox designs and manufactures for America's growth industries: METALS: Rolling Mills • Steel Processing Lines • Rolls • Castings • Open Hearth Specialties • PROCESSING: Process Design, Engineering and Plant Construction Services • Process Equipment and Pressure Piping • CONSTRUCTION: Concrete and Bituminous Paving Machines • Concrete Batching Plants and Forms Gratings • AEROSPACE: Fixed and Steerable Antennas • Radio Telescopes Towers and Special Structures • POWER: Power Plant Specialties and Valves

ENGINEERED GASKETS
for Plant Maintenance



Exacting control of gasket density is obtained by varying the number of metal plies and filler material to seal a specific pressure.

Controlled density is the reason why Garlock *Guardian Gaskets offer you unusual sealing ability.** A series of V-shaped metal plies alternated with layers of filler form the "body" of GUARDIAN spiral-wound gaskets. The proper selected thickness of filler material and preformed metal, the number of laminations of filler and metal and the correct tension of filler and metal while being formed into a gasket are factors engineered to achieve the proper gasket density.

This controlled density—combined with the special V-shaped metal plies—allows the gasket to "breathe." Thus, a tight seal is effected at all times despite equipment or line expansion and contraction. In no other type of gasket is it possible to vary the compressibility to meet different pressure and bolt load requirements.

Complete range of sizes, shapes and wide temperature range are more reasons for specifying Garlock GUARDIAN Gaskets . . . 1/16" thickness up to 6", 1/8" up to 30", .175" up to 60" and 1/4" thick up to 60" depending on flange width. For temperatures up to +1900° F. with ceramic filler material.

Type CR GUARDIAN Gaskets are furnished with a cadmium plated centering ring for corrosion resistance and prolonged shelf life. Centering ring also is marked with the pressure series —assuring application of correct gasket density for specific pressure.

Convenient local stocks of most standard sizes are maintained at Camden, New Jersey, Cleveland, Ohio, Houston, Texas and San Francisco, California, for quick delivery.

GARLOCK

Find out more from your Garlock representative at the nearest of the 26 Garlock sales offices throughout the U. S. and Canada, or write for catalog AD-176, Garlock Inc., Palmyra, N. Y.
Canadian Div.: Garlock of Canada Ltd.
Plastics Div.: United States Gasket Co.

Order from the Garlock 2,000... two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

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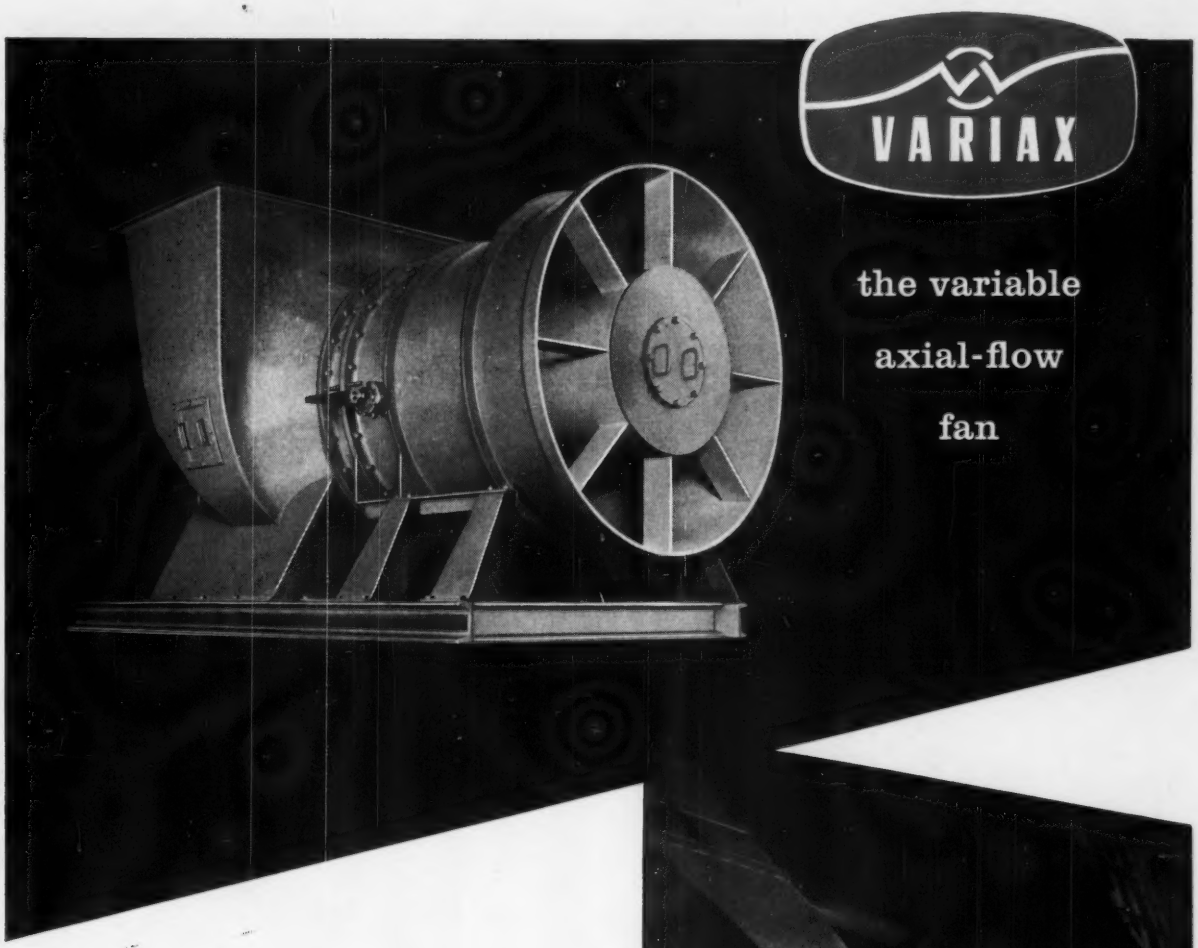
A breakthrough in fan design for induced and forced draft or cooling



- High efficiency over the whole range of regulation.
- Continuous regulation from 0 to maximum output at constant speed.
- Regulates automatically when connected to corresponding boiler control system. Servo-motors of any make may be used.
- Short overall length.

NOVENCO INC

40 Exchange Place, New York 5, N.Y.

HAnover 2-5470

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☐ Please send literature

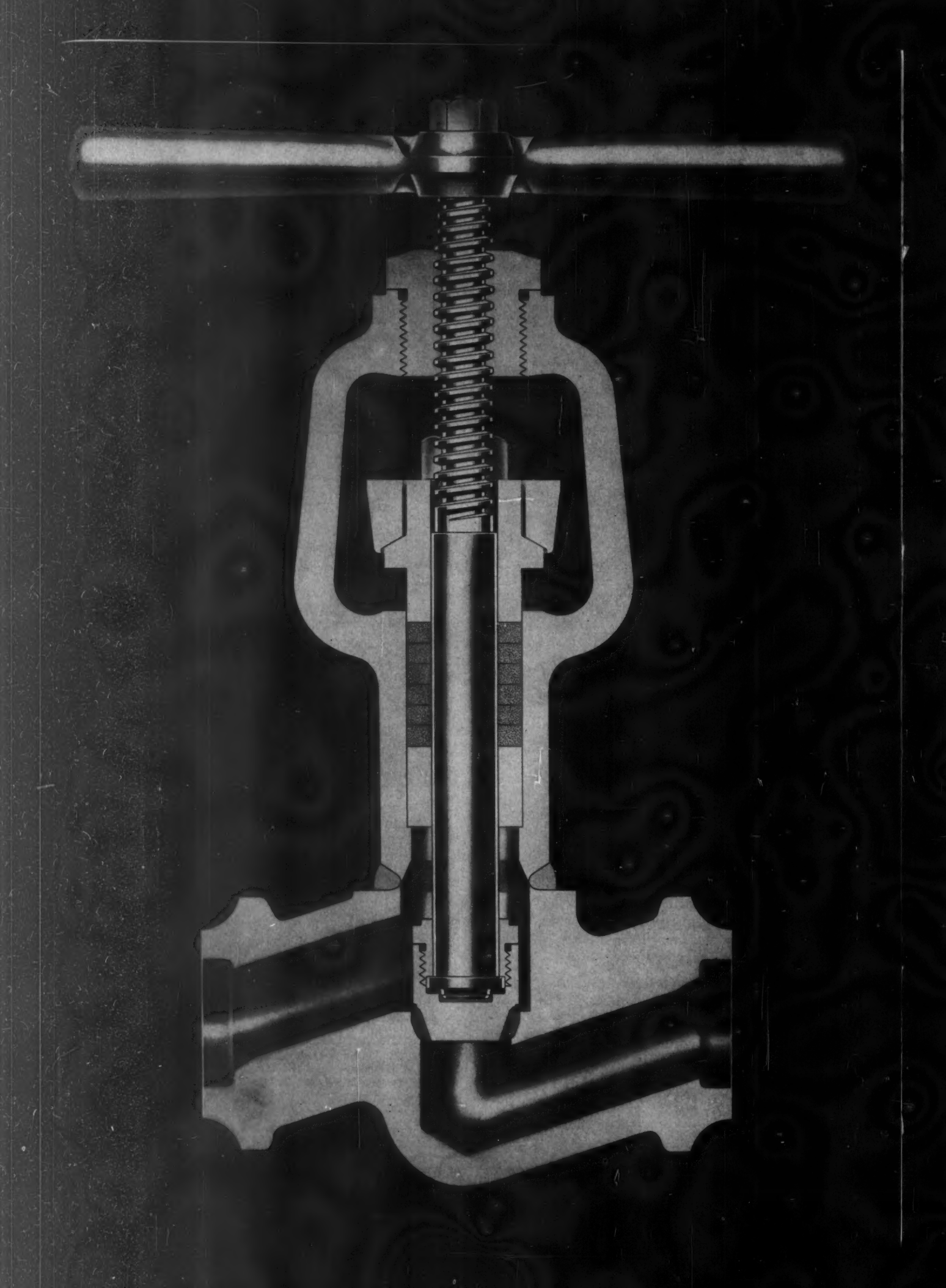
☐ Send information on following boiler capacity.....

Name.....

Address.....

City.....State.....

For more facts circle 212 on Reader Service card, p 109



Valves of quality always let you schedule boiler outages

A valve usually receives serious thought only when BTU losses become substantial and service to customers is endangered . . .

Hancock Steel Valves are the product of leadership in matching boiler and power piping requirements. They set the standard for leakproof valve performance in public utility and industrial power service with designs and materials for conventional, supercritical, and nuclear fueled plants. Each type of valve has that extra measure of quality that keeps modern power generating and all high-pressure process facilities on the line . . . quality that wards off maintenance even under the severest conditions of application.

The valve illustrated at the left is the Hancock Type 7130 Steel Globe Valve widely used by the power and process industries.

For technical assistance in selecting quality Hancock Steel Valves, phone your industrial supply distributor or write for Catalog 200A.

MAXWELL MANNING & MOORE INC. M&M TRADE MARK

HANCOCK Steel Valves

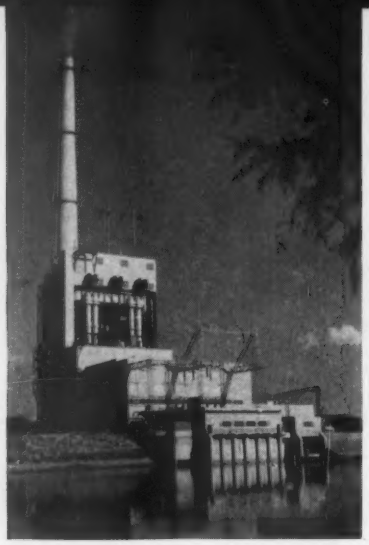
A product of

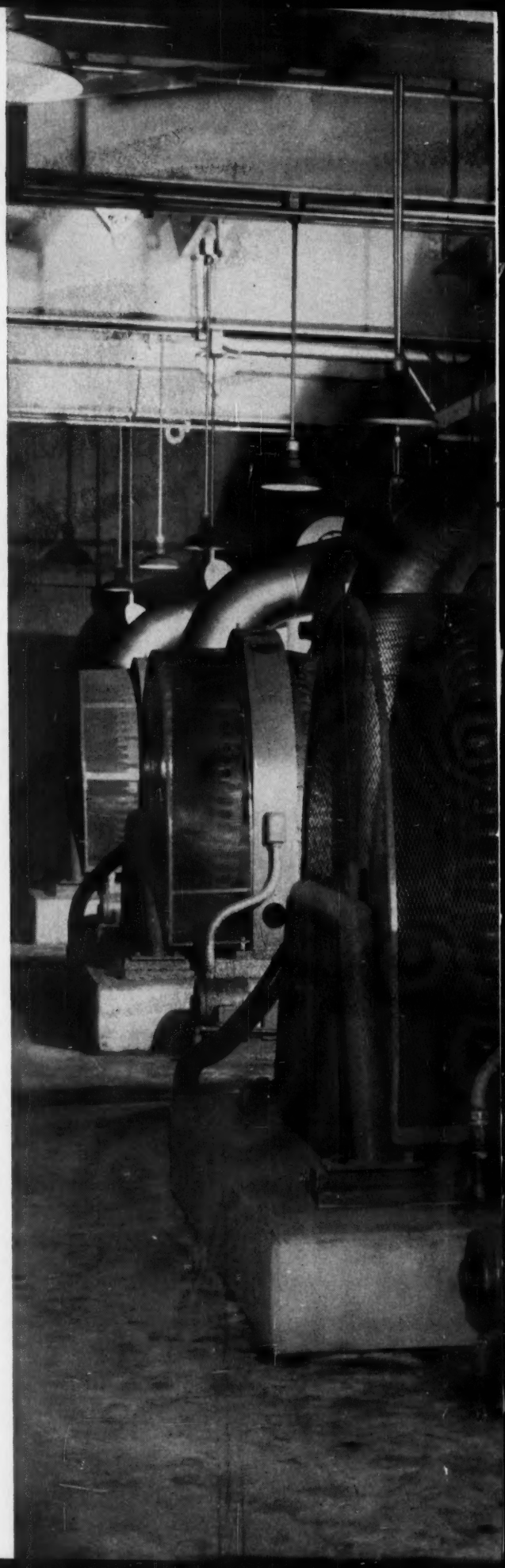
MANNING, MAXWELL & MOORE, INC.

Valve Division, Watertown, Massachusetts

Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario
Latin America: Export Division, Chrysler Building, New York, N. Y.
Europe: Manning, Maxwell & Moore, S.A., Fribourg, Switzerland

For more facts circle 213 on Reader Service card, p 109





Boiler cleaning with air helps Breed Plant reach record efficiency

The new Breed Plant of Indiana & Michigan Electric Company takes only 8530 Btu of fuel to generate one kilowatt-hour . . . the lowest heat rate of any steam-electric plant in history! Designed by and built under the supervision of the American Electric Power Service Corporation, this plant of record size and efficiency, with a single 500,000 kw generating unit, is a milestone in the electric power industry.

To help keep the Breed Plant operating at peak efficiency and lowest cost, AEP specified *compressed air* for furnace and tube bank cleaning. Three 600 hp Cooper-Bessemer FM-3 compressors deliver 2,020 cfm each at 290-350 psi to the slag blowing system of the plant to keep the steam generator surfaces clean and efficient.

Reports from modern power plants show that soot blowing with air increases the capacity, availability and economy of the entire steam generating system. It does the job more thoroughly, uniformly, with less mess and at less cost than with the steam method.

For full details or for assistance on plans for your compression or power facilities, call our nearest office.

BRANCH OFFICES: Grove City • New York • Washington • Gloucester Pittsburgh • Mount Vernon • Detroit • Chicago • Minneapolis • St. Louis Kansas City • Tulsa • New Orleans • Shreveport • Houston • Greggton • Dallas Odessa • Pampa • Casper • Seattle • San Francisco • Los Angeles

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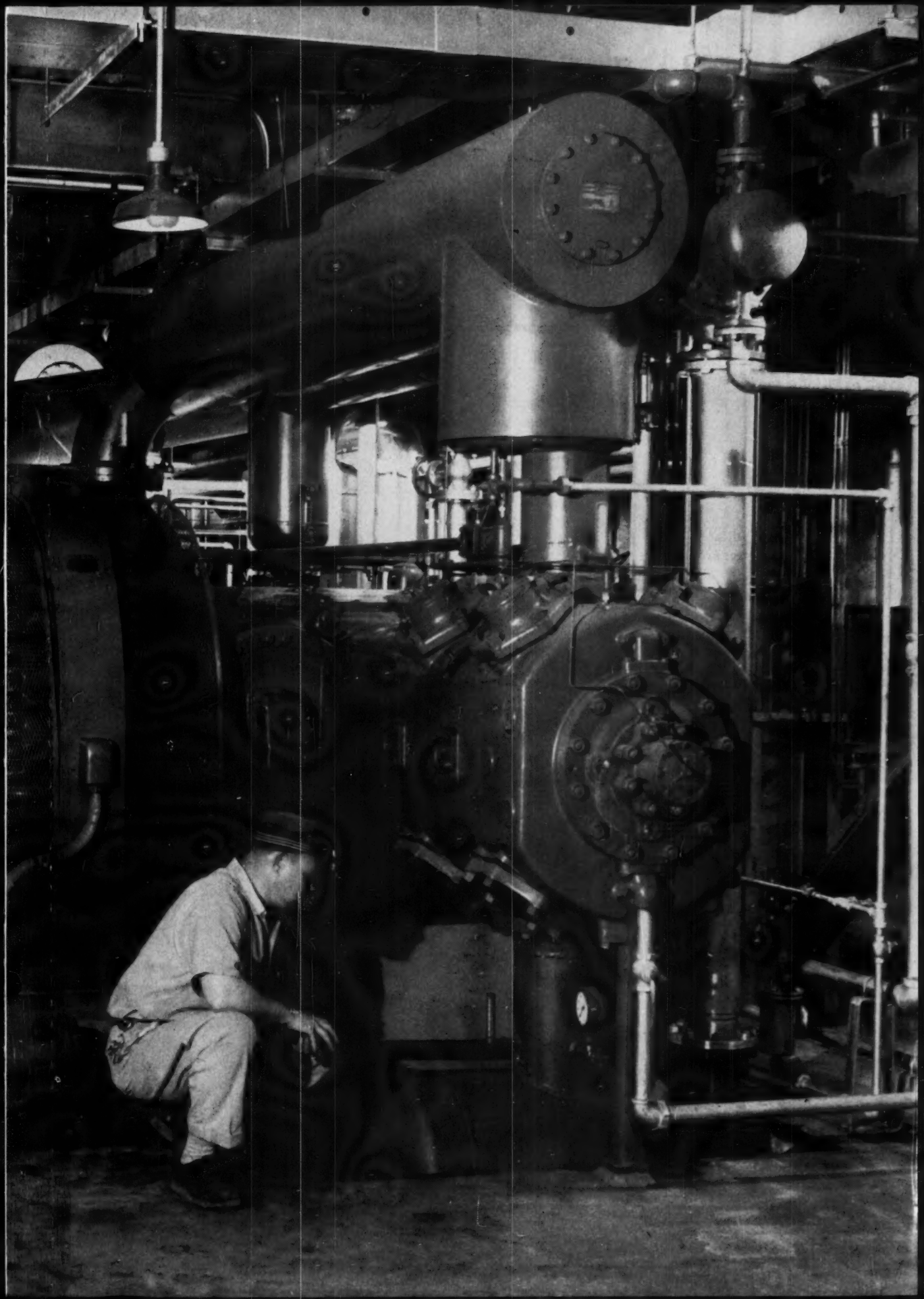
ENGINES: GAS • DIESEL • GAS-DIESEL
JET-POWERED GAS TURBINES

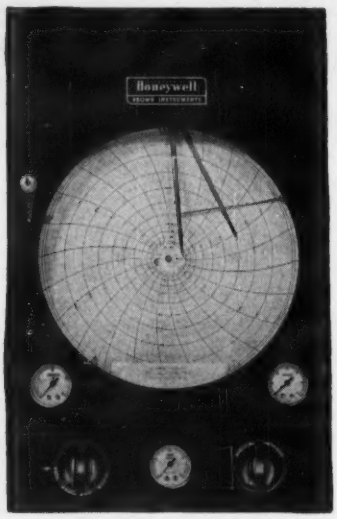
circle 214 on Reader Service card, p 109



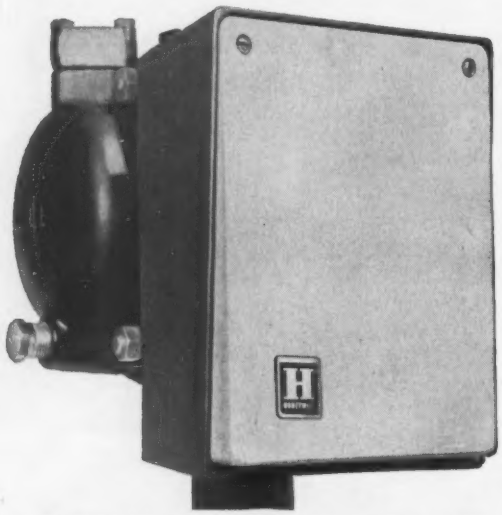
Honeywell Bellows Meter brings

Six of many ways you can use the bellows meter

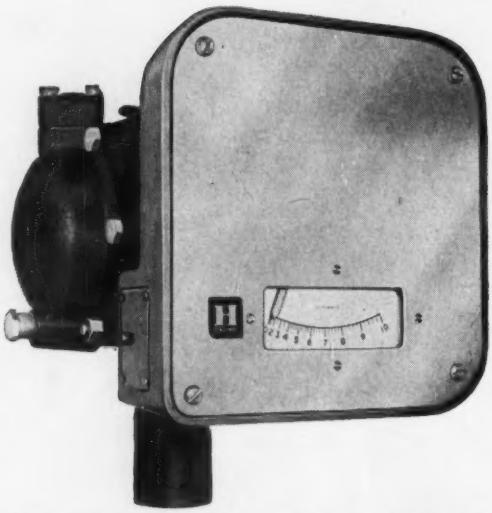
As a Recorder or Integrator—Recorders can have one, two or three pens, with the second and third pens actuated by thermometer or pressure elements. A single-pen recorder is shown above. You can get integration, too.
Write for Specification S 292-2a.



As Recording Controllers—You can get recorders with pneumatic ON-OFF, 10% *Throttlor*, 150% *Throttlor* with manual reset, or *Air-O-Line* (150% proportional band-plus-automatic reset) control. A single-pen pneumatic controller with integral bypass is shown above.
Write for Specification S 292-2a.

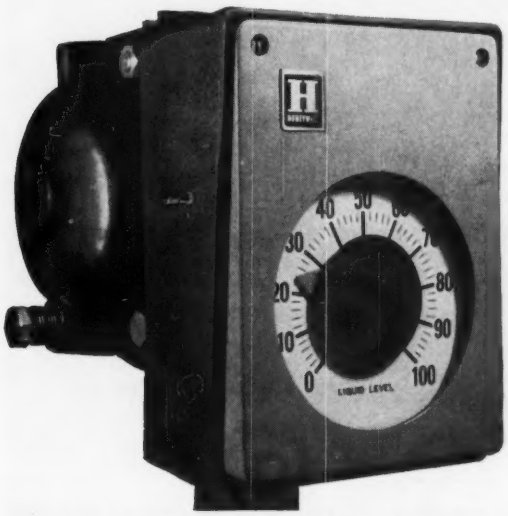


As a Non-indicating Pneumatic Transmitter—Use this non-indicating transmitter when you don't need indication at the point of measurement, and when the measured variable is to be transmitted to remotely located instruments.
Write for Specification S 230-1.



As an Electric Transmitter—You can use this *ElectriK Tel-O-Set* electric flow and liquid level transmitter with indicators, recorders, and controllers, with data handling systems, or with millivolt receivers. Field indication, as shown, is optionally available.
Write for Specification FS 301-7.

new versatility to flow or liquid level measurement



As an Indicating Pneumatic Transmitter—Gives you indication at the point of measurement, plus pneumatic transmission. Easy-to-read scale, and large indicating pointer. Case is only 4 by 7 by 9 inches.
Write for Specification S 230-1.

As a Dial Indicator—Six-inch dial indicator gives easy, accurate readings at point of measurement. This meter-indicator is designed specifically for field indication.
Write for Specification S 224-1.

You can use the Honeywell Bellows Flow Meter as a recorder, controller, indicator or transmitter . . . pneumatic or electric. Use it for accurate, low-maintenance metering of flow—for steam, water, gas, oil or other fluids—or for liquid level measurement. In all of its many forms, with all of its performance advantages and operating economy, it is the most advanced flow and liquid level meter available today.

Some outstanding features:

Stability—The meter body will operate over an ambient temperature range of —40° to 250°F. Over a range from —32° to 150°F. the accuracy will not change more than 0.5%.

Leakproof construction—Hydraulically formed stainless steel bellows eliminate any chance of leakage between fill and process fluid.

Quick, easy damping—Rectangular orifice pulsation check varies the speed of response over a ratio of 20 to 1. Adjustment is essentially linear and can be made from outside the meter body while the instrument is operating.

Sensitivity and accuracy are well within the required limits of measurement and control on applications for which these instruments were designed.

Convenience—Change range easily in the field by replacing a single range spring assembly. The meter body is self-venting when measuring liquids and installed below the flow line; self-draining when measuring gas and installed above the flow line.

There are models of the Honeywell Bellows Flow Meter available in many ranges, for every application. Your nearby Honeywell field engineer can give you complete details and help you select the correct model for your application. Call him today.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

Honeywell

First in Control

SINCE 1885

HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

Water Hunting . . . With water all around us, in oceans, lakes and rivers, the hunt for suitable water still continues. Practically all water used in industry must be treated before use; and Cochrane, specialists in industrial water conditioning for almost a century, are constantly finding new and better methods of treating water. ● Cochrane has made many significant contributions to the art of water conditioning. They pioneered methods for removal of corrosive dissolved gases from water, developments which now form the basis of modern deaeration systems . . . Introduced advanced designs for silica reduction by demineralization . . . And in the softening of water, either by ion exchange or precipitation, many outstanding installations are meeting the stringent requirements of today's industry. ● Regardless of the raw water analysis, Cochrane's experience, covering every phase of water treatment, is your assurance of an unbiased recommendation and satisfactory performance. In water conditioning . . . the name is Cochrane. For complete equipment catalog, write on your company letterhead to Cochrane Division, Crane Co. 3106 N. 17th Street, Phila. 32, Pa.

at the heart of home and industry

COCHRANE DIVISION **CRANE** WATER CONDITIONING

plumbing
heating • air conditioning
valves and piping
electronic controls

For more facts circle 216 on Reader Service card, p 109

HOW SUPERIOR'S 4-PASS DESIGN...

gives you . . .

TAPER-TUBE EFFICIENCY

The long-lived efficiency of Superior Packaged Boilers results from fundamentals of design which are basically sound. Superior's 4-pass, down-draft design provides a minimum of 5 sq. ft. of heating surface for each unit of horsepower rating; **and every inch of that heating surface is effective.**

Why 4-PASS?

Theoretically (from the standpoint of heat transfer alone) the fire passes of a perfectly designed fire tube boiler would resemble a long, very gradually tapered cone surrounded by water. The large end would be sized in ratio to the volume and speed of the combustion gases so that the gases would be crowded into the tube and thus "scrub" the walls of the tube, forcing contact between fire and tube surface. As the gases give up their heat to the surrounding water (by transfer through the tube) the gases shrink in volume. The gradual taper of the tube compensates for this shrinkage, maintaining the scrubbing action which promotes efficient heat transfer.

Such a fire tube is impractical; but Superior's 4-pass design achieves the same effect. Its 4 passes are so designed that each successive pass has a lesser number of tubes (and hence a smaller area in cross section) for the passage of combustion gases. This is, in effect, **taper-tube** performance which results in the maximum practical efficiency of heat transfer . . . performance which makes it possible for Superior to guarantee **more** than 80% thermal efficiency **under field operating conditions.**

Superior Packaged Boilers are completely factory assembled, backed by undivided responsibility. Burn gas or oil, or both. Sizes from 20 to 600 b.h.p. for pressures up 250 p.s.i. or for hot water.

For condensed data describing the World's Most Complete Line of Packaged Boilers write today for Catalog S-11

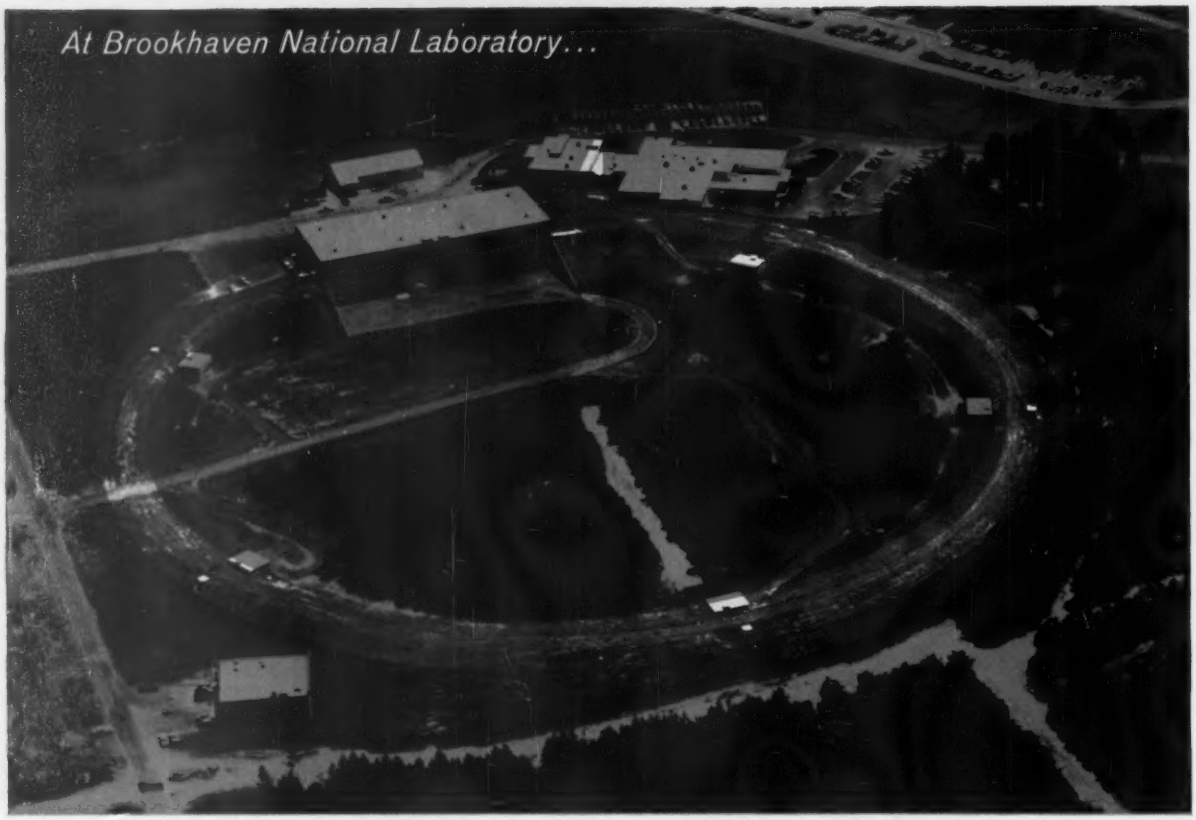
Fire-Tube and Water-Tube PACKAGED BOILERS

for STEAM or HOT WATER

SUPERIOR COMBUSTION INDUSTRIES INC.

TIMES TOWER, TIMES SQUARE, NEW YORK 36, N. Y.

SUPERIOR PACKAGED BOILERS ®



30 Billion Atom-Smashing Volts Keep On Target With Help Of A Sel-Rex Rectifier!

Promising to unlock the innermost secrets of the atom, the world's largest high-voltage proton accelerator circles underground—hidden from the casual observer beneath ten feet of earth and a carpet of new grass.

Named the Alternating Gradient Synchrotron, or AGS, the high voltage atom smasher is the pride of the famous Brookhaven National Laboratory, Upton, N. Y., home of many major achievements in atomic research.

Completed last year, the Accelerator sends pulses of high energy protons hurtling around a circular, half-mile course. This proton thrust steps up in speed and voltage as it circles counterclockwise along its track.

At the end of the high speed run, its protons are traveling at close to the speed of light. This surging force of 30 Billion Electron Volts, directed into a target building, is used experimentally to learn further secrets of the atom . . . to find new particles of matter.

At the heart of Brookhaven's AGS is a series of powerful electro-magnets which bend and focus the circling stream of protons. The vital focusing magnets which aim the high power proton force at the end of its trip are powered by D.C. current from a Sel-Rex silicon rectifier. The rectifier helps focus the shattering 30 Bev force precisely on target with essential reliability.

Just one of the thousands of important jobs Sel-Rex rectifiers are called upon to do in leading plants and laboratories, the Brookhaven application is one in which exacting standards were demanded—and met, as a matter of course!

And for your special current needs—for reliable, continuous conversion of A.C. to D.C.—choose Sel-Rex, the industry-proved rectifiers that more than pay for themselves in unequalled dependability and maintenance-free service.

Send for Free "GUIDE" to Industrial Rectifier Equipment

SINCE MEAKER 1899

THE MEAKER COMPANY

SUBSIDIARY OF SEL-REX CORPORATION

Nutley 10, New Jersey

Factories and Offices Chicago 50, Ill., Los Angeles, Cal. and Nutley 10, N. J.

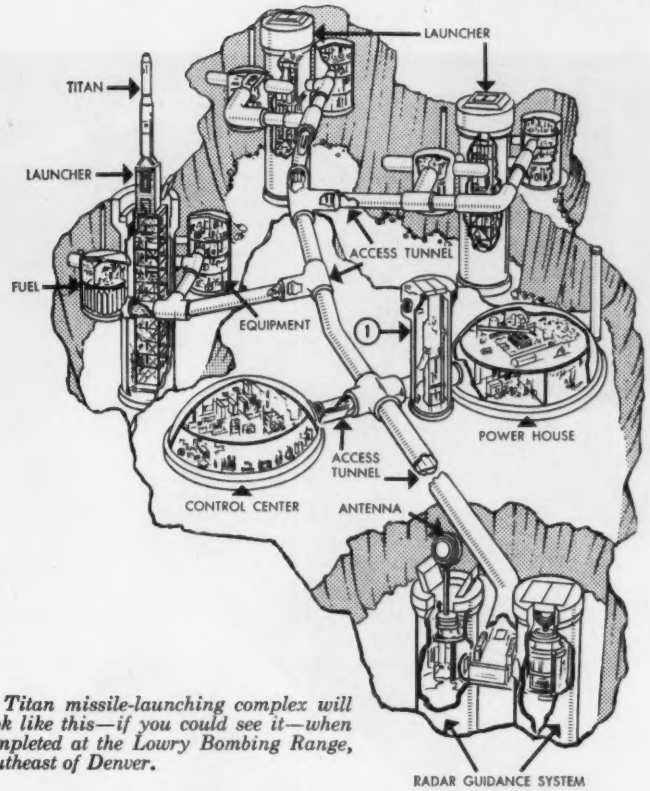
Representatives in principal cities.

Complete Semi-Conductor Power Conversion Equipment and Systems for any AC to DC Application

For more facts circle 218 on Reader Service card, p 109

PUMPAGE

Goulds news about pumps for process industries



A Titan missile-launching complex will look like this—if you could see it—when completed at the Lowry Bombing Range, southeast of Denver.

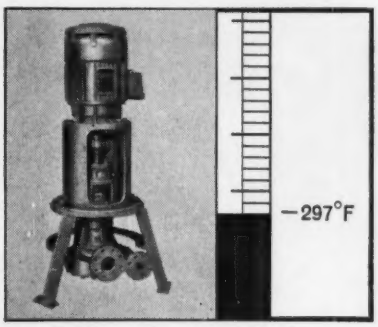
Goulds ductile iron pumps help build TITAN MISSILE MUSCLE

Deep under the Colorado earth, two gigantic Titan missile bases are taking shape. Powerhouse and control center are vast domed structures. Three two-story structures will store fuel. Four-story cylinders will house monitoring and other operating equipment.

Immense and complex, the bases require a wide variety of pumping services. Goulds, the major pump supplier, is building hundreds of units —from vertical sump pumps to high-temperature, high-pressure units.

Many of the pumps *must* be able to stand severe shock so we are making these, or their critical parts, of ductile iron. Castings range from ½ lb. to over 1800 lbs., making up probably the largest order for ductile iron pumps ever placed.

If you'd like to know why ductile iron has unusual resistance to stress, impact, and high pressures, send for Bulletin 765.7.

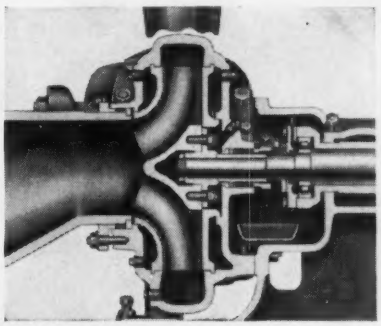


How to pump cryogens

One company pumps liquid oxygen at −297°F with this process pump.

Model 3181's basic design especially fits it for low-temperature pumping. Casing arrangement of suction limits pressure on column, bearings and seal to vessel pressure only. Special magnetic mechanical seal seals shaft.

Cryogens raise special problems in selecting pump design, materials, and seal. Our engineers, experienced in these applications, can help you. Write us.

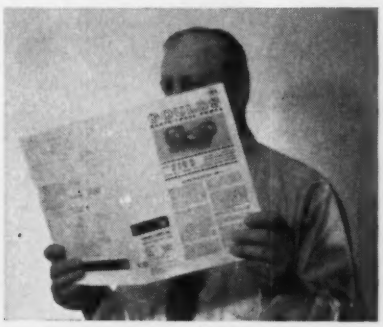


Cotton pickin' pump

Nine Model 3135s pump cotton linter stock *in a smooth flow* for Southern Chemical Cotton Co.

The fine cotton fibers can't clog the open end suction impeller. Ejector vanes on back wall of impeller follow curvature of main vanes, prevent entrance and jamming of stock between wall and stationary sideplate. There is no impeller nut or other obstruction at the impeller eye to catch fibers.

For specifications and performance data, send for Bulletin 723.1.



Now... small-capacity pump for chemicals and slurries

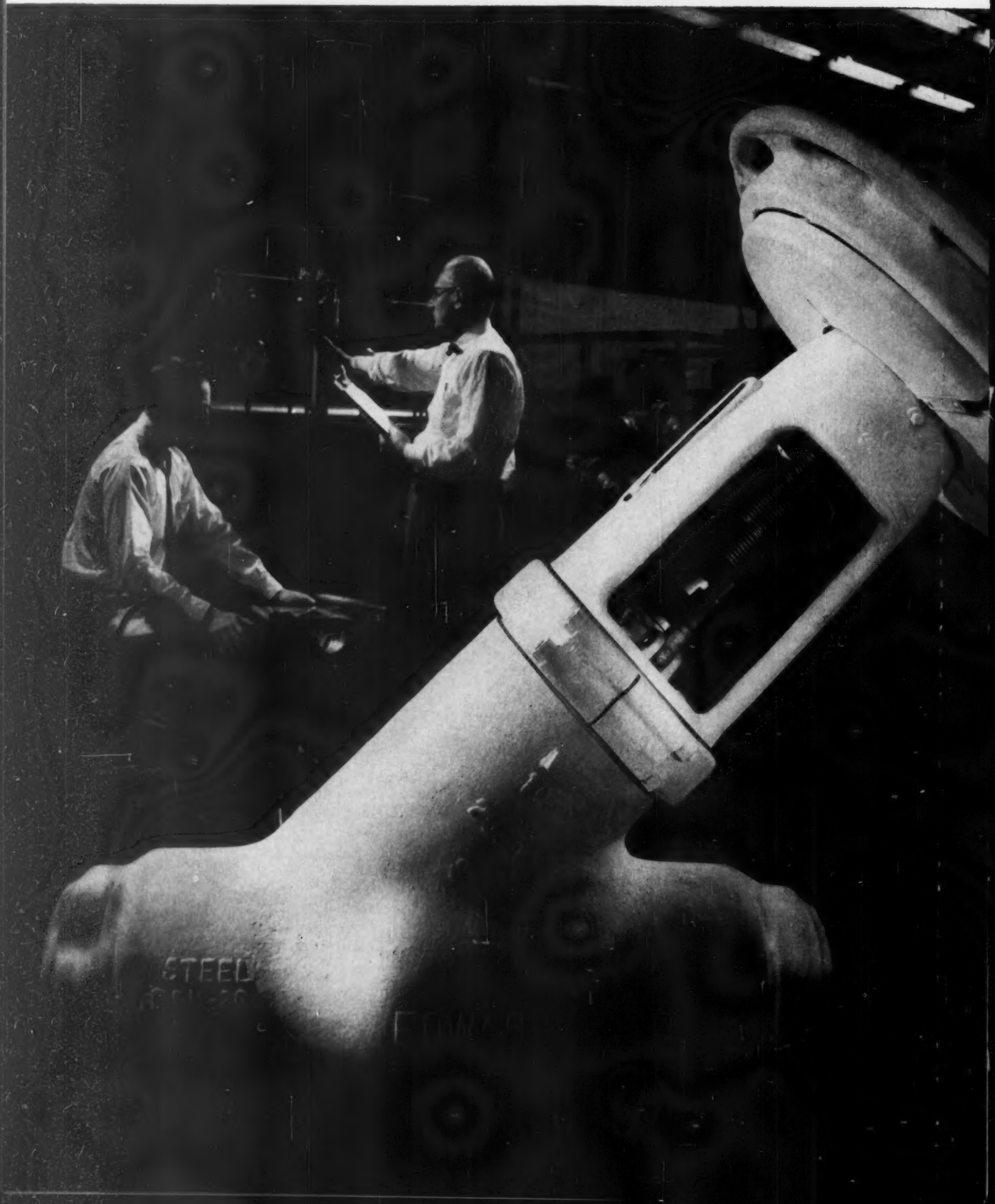
Handles up to 115 gpm of corrosive chemicals, thick or abrasive slurries at heads to 150 ft.

Of single-stage side-suction open-impeller design, Model 3199 has hydraulically balanced impellers with ejector vanes on back wall to keep out solid material and reduce stuffing-box pressure. Bearings are isolated in cooling chamber.

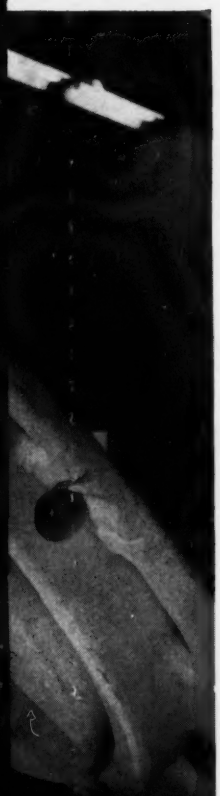
For specs, ratings and other data, write for Bulletin 720.5. Goulds Pumps, Inc., Dept. PO-91, Seneca Falls, New York.

GOULDS PUMPS

How Edward Valve Research



Reduced Pressure Drop 70%



Power industry advances in unit size created a need for large, high pressure steel valves (ten inch size and larger, 1500 lb class and higher) with three basic qualities: 1. Permanent tight seating; 2. Capacity to handle high flow rates being encountered in new, high pressure plants; 3. Reduced downtime through simplified maintenance. Edward researchers developed the Flite-Flow* design to satisfy that need. This is their story.

In 1951 Edward had already developed large cast steel globe valves with excellent dependability and repairability. Long experience in building inclined stem Y-type valves in small sizes indicated that this configuration offered a more efficient flow path. Edward research engineers set out to learn whether sufficiently strong pressure containing structures might be built in the Y-type design in larger sizes. They also sought to find out if pressure drop could be reduced sufficiently to make such a valve practical for high pressure power plant services.

The project consisted of three steps:

1. INTERNAL CONTOUR DESIGN—Flow tests were conducted with a series of plastic models. Early in the testing program it was observed that flow capacity was not always directly related to the size of the opening. Reduction of turbulence proved to be even more important. This eventually led to subtle internal contour changes to pre-shape the flow before passing through the valve seat. More material was added to certain internal areas to gain additional structural strength.

2. DISK GUIDING TESTS—To compensate for the angular position of the stem-disk assembly tests were conducted to determine whether conventional three-point guiding used in vertical stem Edward valves would be adequate for the inclined stem design. Experiments suggested that four equally spaced guiding surfaces would be superior. This is important in floating disk types such as check or stop-check valves where disk-piston assembly must seat automatically.

*T.M. Reg. U.S. Pat. Off.

3. STRUCTURAL STRENGTH—The usual weakness of a Y-type pressure containing vessel received much attention. Optimum valve contour as determined by flow testing permitted use of a structural member in the flow passage at the downstream side of the seat port. This structural member provides strength exactly where needed without significant increase in pressure drop. Introduction of this segment to the valve body casting without sacrifice in pressure drop was a significant achievement.

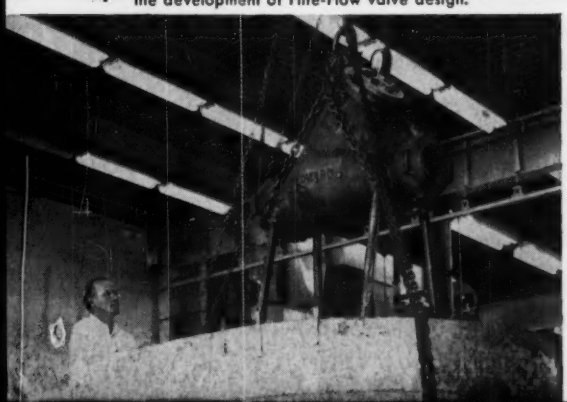
RESULTS: This program covered a period of six years. Tests of the completed design were most gratifying. Structural stability, a major problem, was excellent. Strain gage and brittle lacquer tests of finished valve bodies showed stresses well within acceptable limits. Pressure drop reduction amounted to as much as 70 per cent from best previous globe valve experience. Extended tests of finished product at pressures and temperatures above rating showed no operating weaknesses. The Flite-Flow is truly a dependable, repairable, low pressure drop valve.

Edward builds a complete line of forged and cast steel valves from ¼" to 24" for industrial, marine, petroleum and technological services. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1230 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

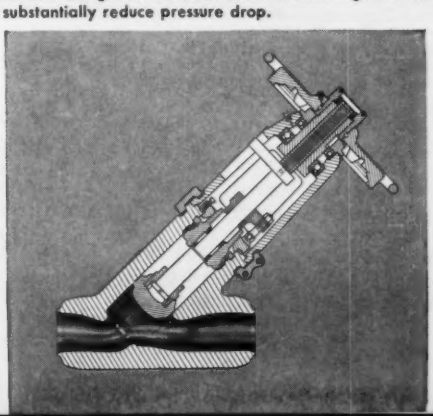
EDWARD STEEL VALVES
another fine product by
ROCKWELL

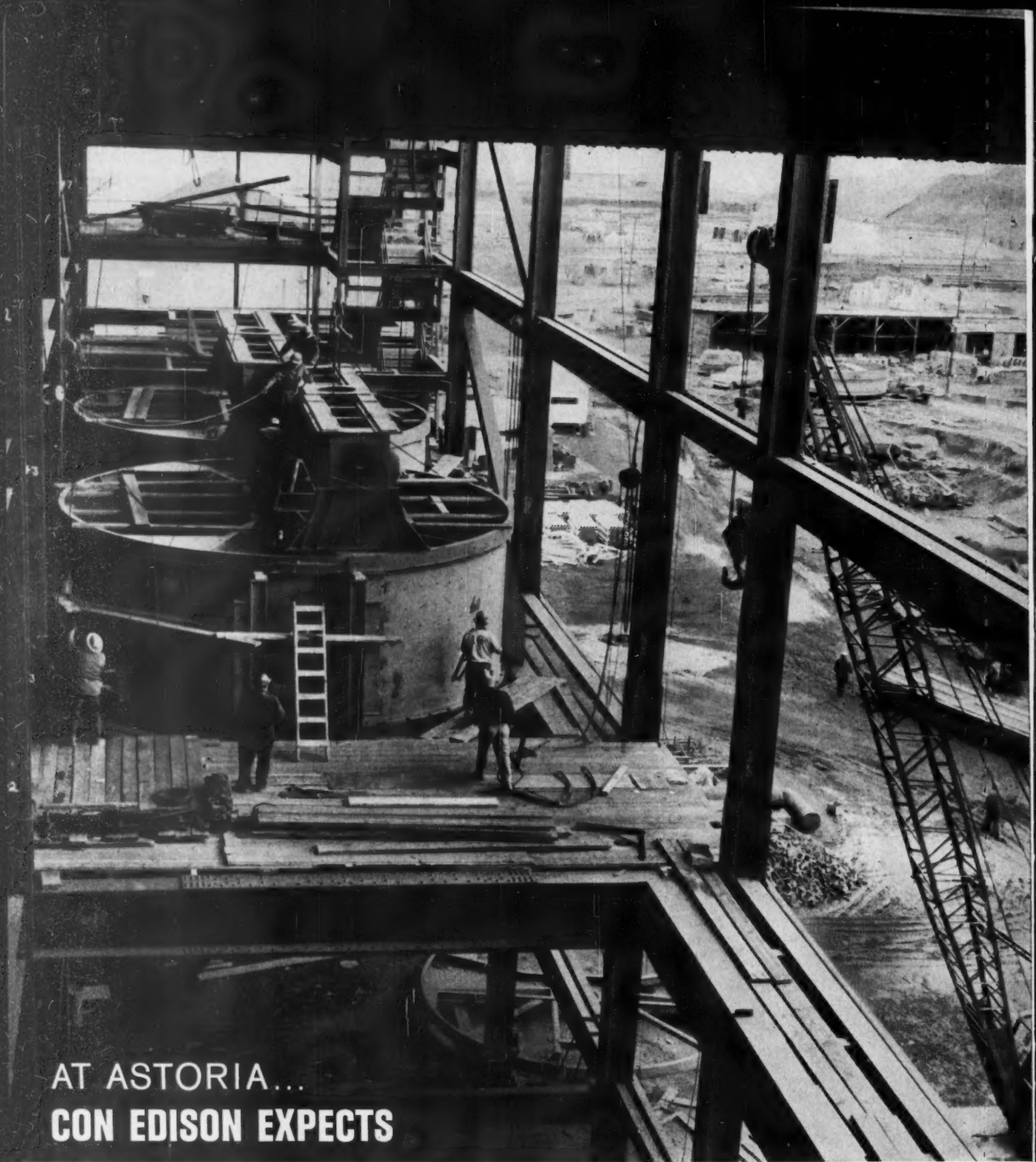
◀ **W. G. Lunt, research engineer, and E. B. Pool, chief research engineer, study flow phenomena in plastic half-model of tentative Flite-Flow design.**

▼ **Edward research team lowers experimental valve into test furnace where it is subjected to prolonged extremes of heat and pressure. This was one of the final steps in the development of Flite-Flow valve design.**



Cutaway view of Flite-Flow valve showing how inclined stem Y-type valve configuration has been adapted to larger size units for power plant services. This internal contour design enabled Edward research engineers to substantially reduce pressure drop.





AT ASTORIA...

CON EDISON EXPECTS

FUEL SAVINGS OF 8% FROM FOUR NEW LJUNGSTROMS®

Four new Ljungstrom Air Preheaters are being installed by Consolidated Edison Company of New York, Inc., on their Astoria Stations' #50 boiler unit. With a total heating surface of about 547,000 sq. ft., these four units are designed to reduce the stack temperature 345° F. By transferring this heat to the incoming combustion air, a fuel savings of about 8% is realized. Addition of these units makes a total of 16 Ljungstroms installed at Astoria . . . 77 either installed or on order in the entire Con Edison system.

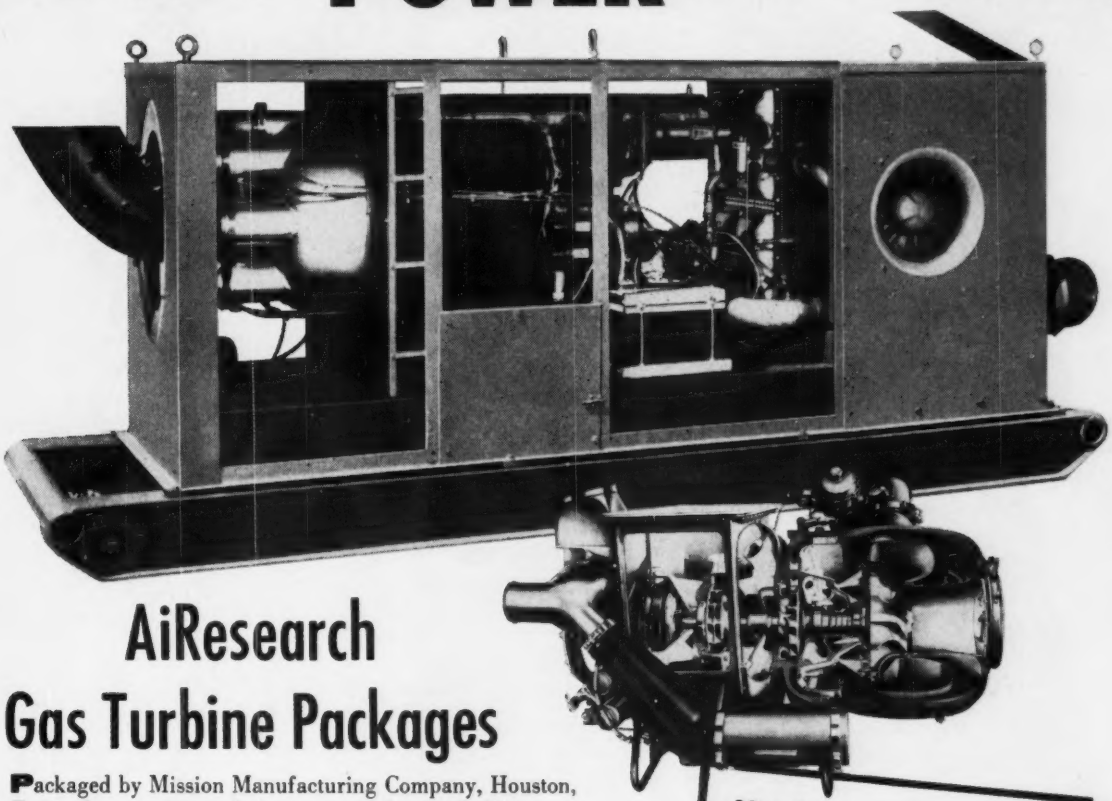
Our engineers will be glad to recommend ways to improve your operating results on new or existing fuel fired units. For information, please write to:

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N.Y.

For more facts circle 221 on Reader Service card, p 109

compact POWER for industry



AiResearch Gas Turbine Packages

Packaged by Mission Manufacturing Company, Houston, Texas, the unit pictured above is used for air drilling and is representative of a number of different types of AiResearch industrial gas turbine power packages now available. These lightweight, compact gas turbine packages provide portable compressed air and shaft power for a wide variety of industrial applications.

The basic power package consists of an AiResearch gas turbine compressor and power unit designed around components and accessories proved by laboratory and field testing over a period of years. It is mounted on a skid, enclosed against the weather, with heat exchangers, operating controls and safety devices.

The Mission packaged GTC 105 AiResearch Gas Turbine Compressor Unit pictured above supplies compressed air only. The cutaway Model GTCP 85-91 AiResearch Gas Turbine Compressor and Power Unit provides shaft horsepower and compressed air simultaneously, or either form of power independently and interchangeably. Other models are also available to supply either type of power alone.

AiResearch Manufacturing Division of Arizona is a world leader in the design, development and manufacture of lightweight turbomachinery.

30 to 850 horsepower in a lightweight, compact, dependable package.

Heat at 10,000 to 100,000 Btu per minute in free-flowing air up to 950°F or compressed air from 90°F up to 500°F.

Dependable quick starting under conditions of heavy dust or sand, extreme heat and cold from sea level to 10,000 feet, reaching peak efficiency in seconds.

High pressure, high volume fluid pumping by a compact, portable unit.

Large volumes of compressed air at 30 to 350 psig at 10 percent of the conventional equipment weight.

Shaft power applications for driving pumps, compressors and other mechanical equipment.

Fuel economy competitive with conventional power.

Long service life between overhauls and low maintenance costs.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

10,000 AiResearch gas turbines now in use • rugged • versatile • compact • lightweight • dependable

For more facts circle 222 on Reader Service card, p 109

Lined against corrosion with gunited concrete

The lining being applied – of corrosion-resistant concrete made with LUMNITE calcium-aluminate cement and insulating aggregate – will soon be protecting stack and breeching from the corrosive action of flue gas condensate.

It will also keep stack gases hot, maintaining better draft for greater operating efficiency. Steel shells will stay cooler, extending exterior paint life. And monolithic concrete linings have lower unit weight, reducing dead load on supporting structure. Gunited or plastered, installation is easy and economical, with the concrete reaching service strength in 24 hours. For convenience, manufacturers of refractories offer castables bonded with LUMNITE cement – packaged mixtures ready to use by adding only water.

For more information, write Universal Atlas, 100 Park Avenue, New York 17, N. Y.

Offices: Albany • Birmingham • Boston • Chicago • Dayton • Kansas City • Milwaukee • Minneapolis • New York • Phila. • Pittsburgh • St. Louis • Waco

"USS," "ATLAS" AND "LUMNITE" ARE REGISTERED TRADEMARKS L-213

Universal Atlas Cement
Division of
United States Steel

USS

• 336 •

For more facts circle 223 on Reader Service card, p 109

THREE | GREAT | SERIES

A MARSH Valve for every purpose

Ask for bulletins

These three bulletins, covering alloy steel, 416 stainless steel, and 316 stainless steel valves will be sent to you in a binder. Write.

Yes, three great series of needle throttling valves. Great in design and construction. Great in range of corrosion resistant service. Great in range of sizes and patterns.

All three series share the basic design and construction that has set new standards for Marsh Needle Valves.

All give smooth, close regulation and positive shut-off from a few pounds pressure up to high pressures.

All have body and stem guides machined from solid bar stock to provide extra strength and valve life.

All have precision ground stems and long fine-pitched accurately-machined stem threads for micrometer regulation and tight shut-off.

All have deep inlet and outlet threads for tight make-up.

All have special, long-lasting, readily-replaced, special "Marpak" packing incorporating all-but-indestructible Teflon in the stainless steel series.

You see a globe valve representing each series here. Note that the color of the handle identifies the series. Valves come to you individually sealed in strong, transparent plastic packages. In appearance, in operation, in service life you have in these valves the kind of product that only Marsh experience in *both* valve making *and* instrument making could produce.

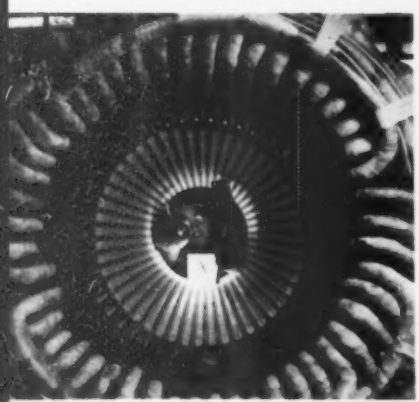
Globe and angle valves in all three series are available with double female connections in sizes ⅛", ¼", ⅜", ½", ¾" and 1"—with male inlet and female outlet in sizes ¼" and ½". Panel mounted types in all sizes. Write for bulletins.

MARSH INSTRUMENT COMPANY, Dept. F
Skokie, Ill. *Division of Colorado Oil & Gas Corporation*
Marsh Instrument & Valve Co., (Canada) Ltd.,
8407 103rd St., Edmonton, Alberta, Canada
Houston Branch Plant, 1121 Rothwell St.,
Sect. 15, Houston, Texas
Eastern Seaboard Warehouse: Marsh Instrument Co.,
1209 Anderson Ave., Fort Lee, N.J.

MARSH *Needle Valves*

Westinghouse supplies all these vital mechanical components for nuclear reactor plants

Canned Motor Pumps. This skilled technician is machining a canned motor pump shell and flange on a modern 100" vertical boring mill. Pump is an important nuclear reactor component.



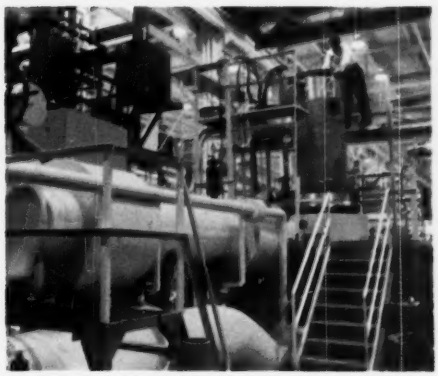
Quality Control. All equipment manufactured by the Atomic Equipment Department is subjected to maximum quality controls. Stringent hydraulic, electric and mechanical inspections result in essentially maintenance-free performance.

Nuclear Reactor Valves. This 20" motor operated gate valve has been machined and is ready for testing before shipment for SELNI in Italy. Valve is one of many Westinghouse designs for reactor plant primary systems.

Modern Production Facilities. Advanced production and testing equipment in modern plant at Cheswick, Pa., make Westinghouse Atomic Equipment Department the most complete facility of its type in the world.

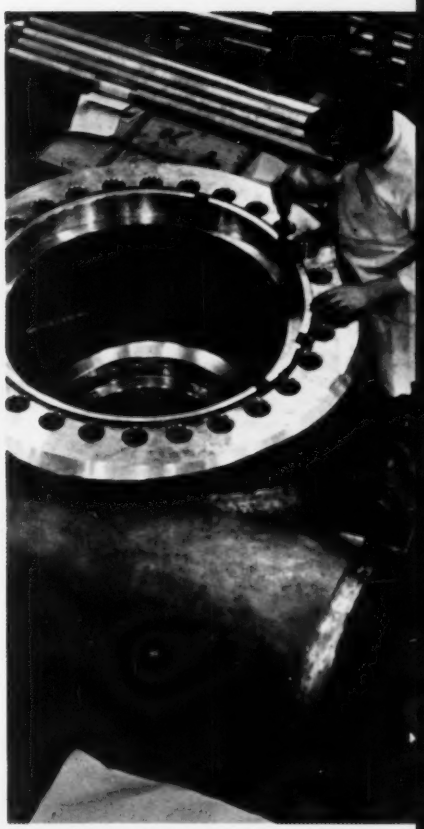
Control Rod Mechanisms. Inspector is working on a control rod mechanism to be installed in new Saxton, Pa., reactor. Moving parts of mechanism are hermetically sealed.

...and canned pumps for controlled circulation boilers

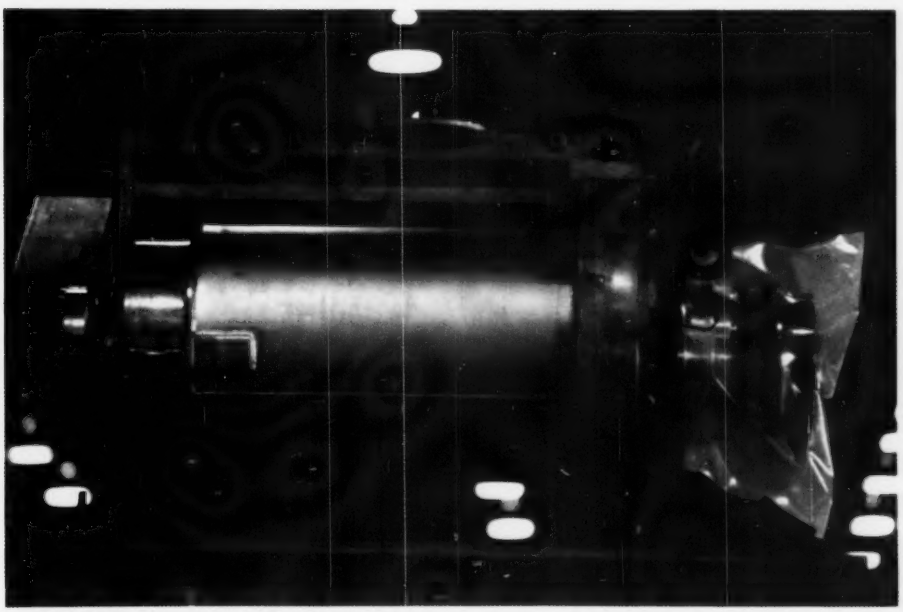


Test Loops. Eight test loops are available at the Atomic Equipment Department for rigid testing of all products. Loops can be adapted to handle flows from 1 to 40,000 g.p.m.

Westinghouse Pumps Installed. Three Westinghouse canned motor pumps are shown installed in power plant in Hartsville, South Carolina. Motor and pump casing completely enclose the pump shaft, eliminating the problems of the seal-injection system.



Pump Casing. This nine-ton steel casing will be installed with a canned motor pump in a nuclear reactor plant. Casing and pump form a leakproof unit.

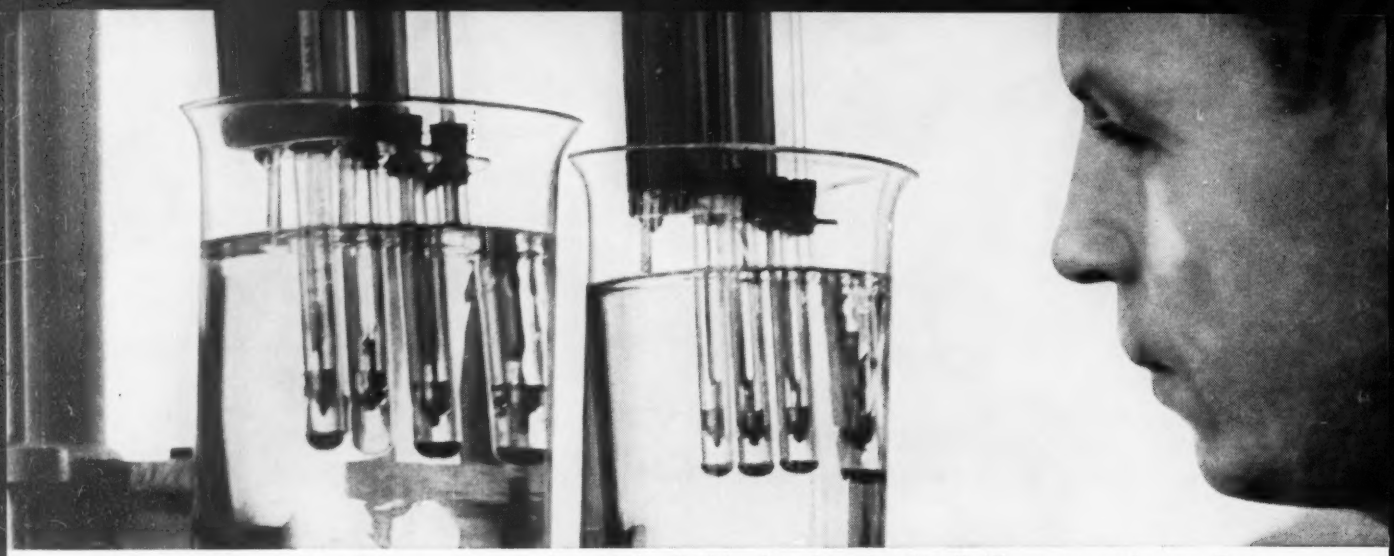


Controlled Circulation Boiler Pumps. Westinghouse manufactures canned motor pumps such as this for service with Combustion Engineering controlled circulation boilers. Standardized pumps are available in many head and flow combinations for these high temperature, high pressure boilers.

J1-58005

You can be sure if it's

Westinghouse



Dropping point test shows how greases react to heat. Beaker fluid has been heated to 390°F. All greases tested except Darina (second tube from let) have passed from solid to liquid state.

BULLETIN:

Shell reveals the remarkable new component in Darina Grease that helps it save up to 35% on grease and labor costs

Darina® Grease is made with Microgel*, the new thickening agent developed by Shell Research.

Darina lubricates effectively at temperatures 100° hotter than most conventional soap base greases can withstand.

Read how this new multi-purpose industrial grease can help solve your lubricating problems and even save you up to 35% on grease and labor costs.

THERE IS no soap in Darina Grease. No soap to melt away—wash away—or dissolve away.

Instead of soap, Darina uses Microgel—a grease component developed by Shell Research.

What Microgel does

Because of Microgel, Darina has no melting point. It won't run out of gears or bearings.

Compared with most conventional soap-base greases, Darina provides significantly greater protection under adverse service conditions.

Mix water into Darina and the grease does not soften. It shrugs off water—won't emulsify.

Resists heat

Darina will withstand operating temperatures 100° hotter than most conventional multi-purpose greases. It cuts leakage and reduces the need for special high-temperature greases.

Also, Darina resists slumping, thus forming a more effective seal against foreign matter.

Saves money

Shell Darina can reduce maintenance expenses while it protects your machinery. Savings of up to 35% on grease and labor are quite possible.

In some cases lubrication intervals have been extended to double what they were before. Less grease is consumed and less time consumed applying it.

For details, see your Shell Representative. Or write: Shell Oil Company, 50 West 50th Street, New York 20, New York.

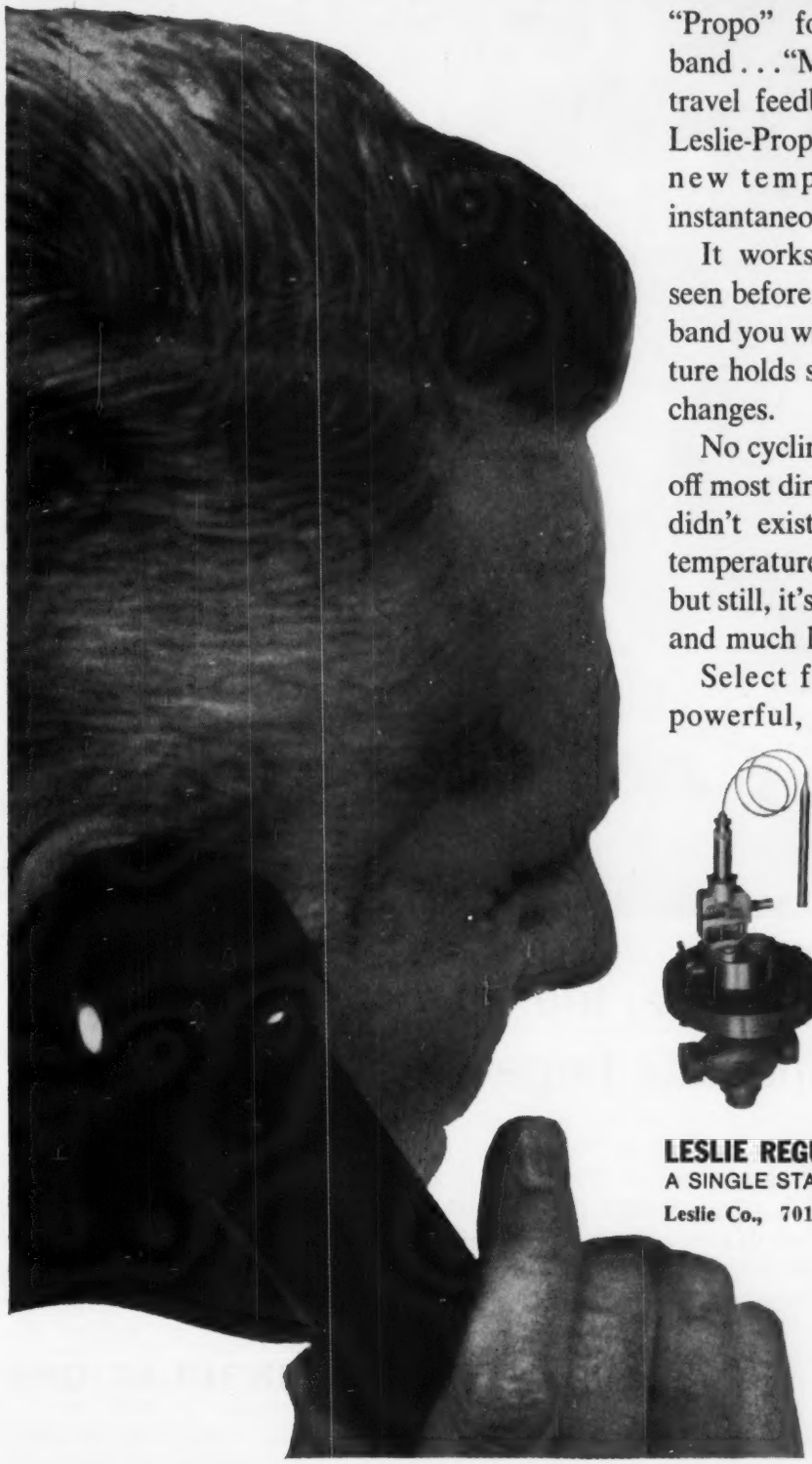
*Registered Trademark

SHELL

A BULLETIN FROM SHELL
–where 1,997 scientists are helping to provide better products for industry

The best name we can think of is

PROPOMATIC



"Propo" for adjustable proportional band . . . "Matic" for automatic valve travel feedback. Put them together — Leslie-PropoMatic® — and you get the new temperature regulator for instantaneous-type heater service.

It works like nothing you've ever seen before. Set the dial for the control band you want, and that's all. Temperature holds steady, even under fast load changes.

No cycling. It's stable! And it shrugs off most dirty steam problems as if they didn't exist. In *effect* it's a pressure-temperature cascaded *control system*—but still, it's a *regulator*—easy to install, and much less in initial cost!

Select from 50F, 100F or 200F powerful, interchangeable thermo elements. Bronze or iron, ½ to 4″, screwed or flanged ends. PropoMatics handle inlet pressures to 150 psi, temperatures as high as 500F.

Engineering Data Bulletin 611 has all the data on PropoMatics. Send for it —no obligation.

LESLIE REGULATORS AND CONTROLLERS

A SINGLE STANDARD OF QUALITY SINCE 1900

Leslie Co., 701 Grant Ave., Lyndhurst, New Jersey

TRADE LESLIE MARK

For more facts circle 227 on Reader Service card, p 109

Armaflex sheets . . . the faster, better way to insulate large fittings

Contractors save time when they use Armaflex foamed plastic sheets to insulate large fittings in the sub-zero to 200F range. Armaflex sheets often can be installed at lower costs than conventional insulations, too, and they do a more efficient job. They are easily cut for accurate fit, quickly positioned and secured with Armstrong Adhesive at the joints, need no mechanical support, and are vaporproof. The completed installation has a clean, professional look, and cleanup can be done quickly with a dustpan and broom.

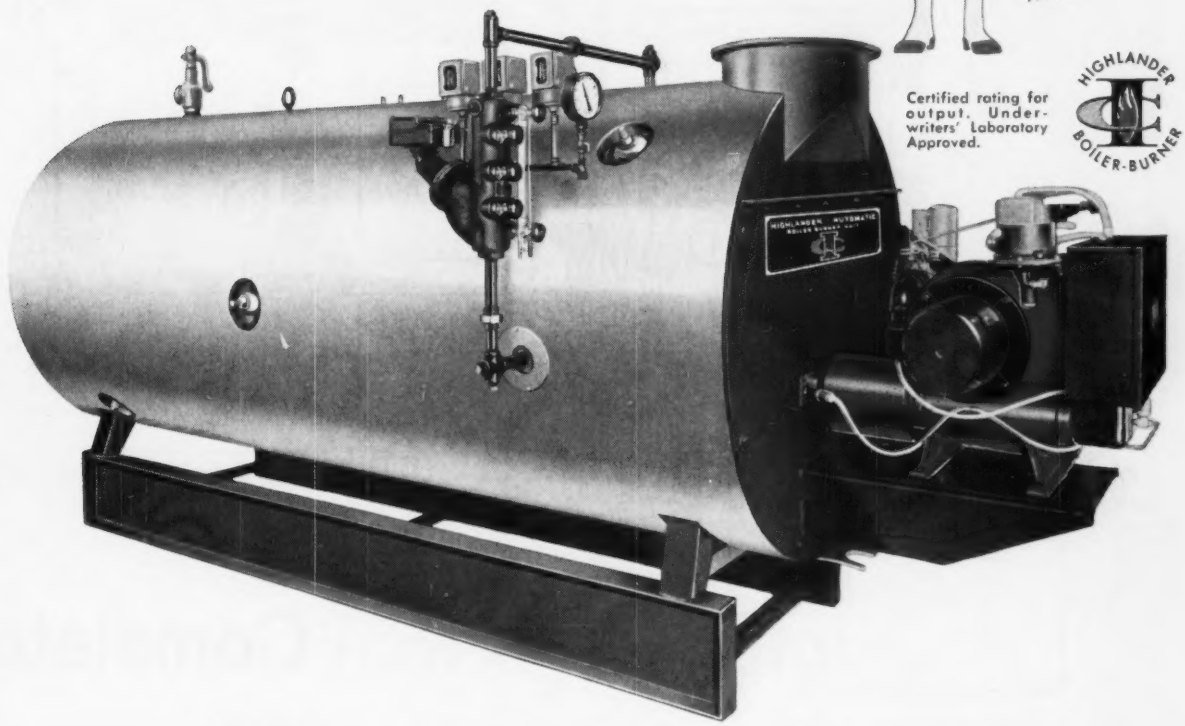
Armaflex sheets are one of a complete line of Armstrong products, including flexible Armaflex 22 Pipe Covering, Rigid Armaflex for compression resistant application, and Armaflex Finish and Adhesives for a neat and permanent job. For complete product information and specifications, write today to Armstrong Cork Company, 2209 Riggs Avenue, Lancaster, Pennsylvania.

Armstrong INSULATIONS

ARMAFLEX 22 • RIGID ARMAFLEX • SHEET ARMAFLEX • ARMAFLEX FINISH • ARMAFLEX ADHESIVES

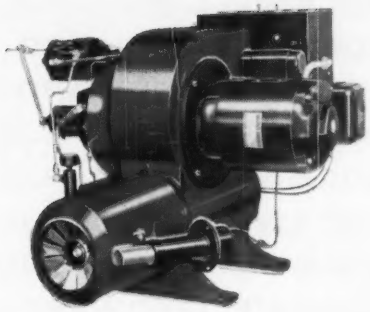
For more facts circle 228 on Reader Service card, p 109

NEW
HIGHLANDER
COMPLETELY AUTOMATIC BOILER-BURNER UNIT



Certified rating for output. Underwriters' Laboratory Approved.

HIGHLANDER BOILER-BURNER



YOUR CHOICE OF HEV-E-OIL, HEV-E-DUTY GAS or COMBINATION GAS and OIL BURNER

HEART OF THE HIGHLANDER is the famous Industrial Combustion Burner. The HEV-E-OIL Burner engineered to use inexpensive No. 4, 5 and 6 heavy oils is shown here. Available from 5 to 150 gph. HEV-E-DUTY Power Gas Burners and Combination gas/oil Burners from 720,000 to 21,000,000 BTU.

Write Dept. J-91 for complete information.

PROVEN ECONOMY

SAVES ON INSTALLATION. The new Highlander is a completely assembled boiler-burner plant. Installing one simple unit saves money. Designed by Engineers with years of experience in matching burners and boilers for the exact job — whether it is power, processing or heating. No problem of taking a boiler and trying to match a burner to it. The Highlander Boiler-Burner unit is design-controlled at the factory for maximum reliability.

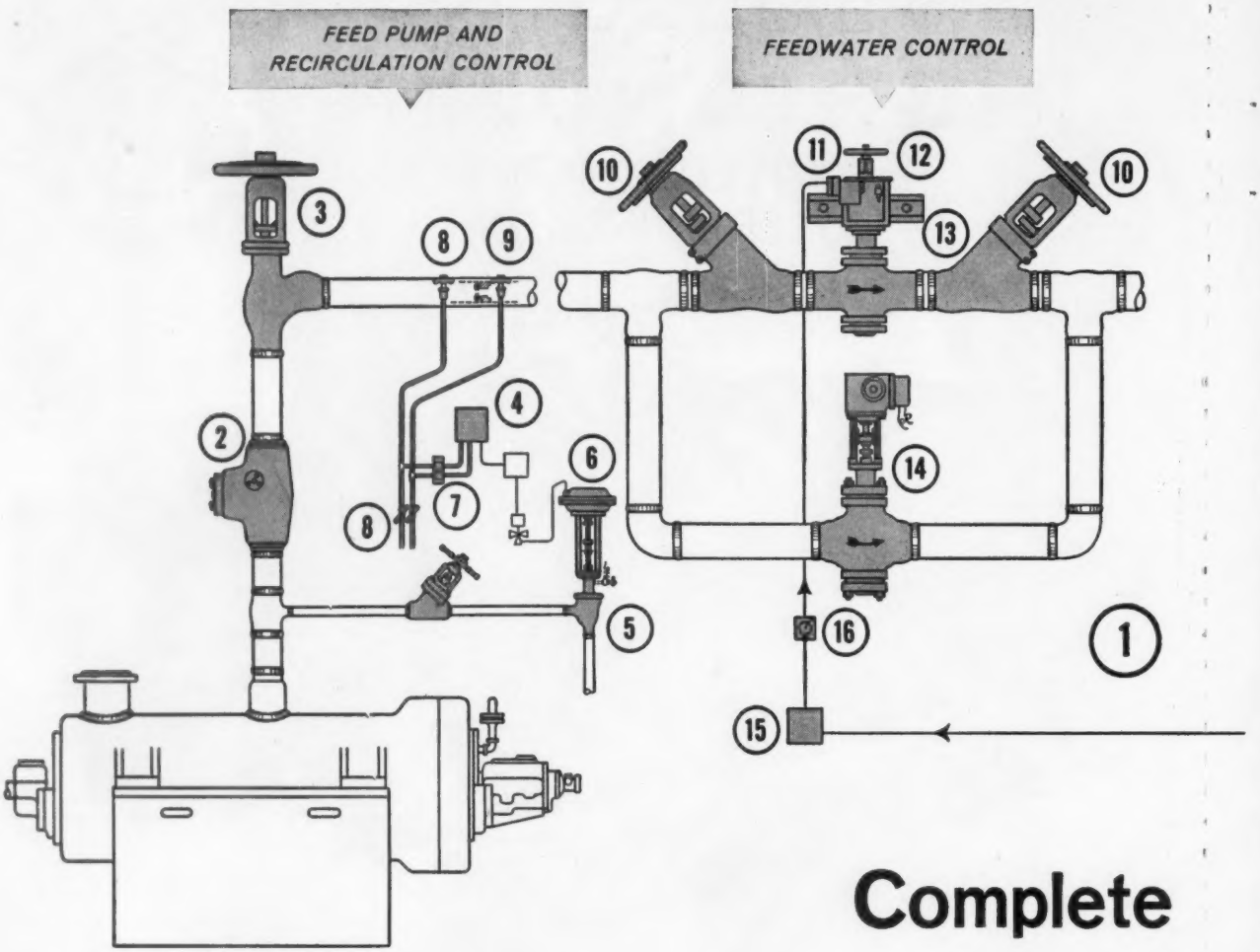
SAVES ON OPERATION. Designed to get maximum economy from available fuels. The Highlander is built for low pressure or high pressure steam or hot water — Industrial Combustion burner furnished for a heavy oil, light oil or combination of gas/light or gas/heavy oil. Simple! Just 2 flue passes. Easy Maintenance! Boiler interior easily accessible. Reliable! Each burner is completely fire tested at the factory.

INDUSTRIAL COMBUSTION INC.

EXECUTIVE OFFICES: 4447 N. OAKLAND AVE., MILWAUKEE 11, WIS.

For more facts circle 229 on Reader Service card, p 109

Boiler·feedwater



Complete

1	System engineering by	ROCKWELL-REPUBLIC
2	Tilting disk check valve by	ROCKWELL-EDWARD
3	Stop or stop-check valve by	ROCKWELL-EDWARD
4	Transmitter and controller by	ROCKWELL-REPUBLIC
5	By-pass angle valve by	ROCKWELL-REPUBLIC
6	Diaphragm operator by	ROCKWELL-REPUBLIC
7	Manifold valves by	ROCKWELL-REPUBLIC
8	Uni-valves for shut-off by	ROCKWELL-EDWARD
9	Orifice flow section by	ROCKWELL-REPUBLIC
10	Flite-flow stop valves by	ROCKWELL-EDWARD
11	Positioner by	ROCKWELL-REPUBLIC
12	Toggle head valve operator by	ROCKWELL-REPUBLIC
13	Control valve by	ROCKWELL-REPUBLIC
14	Motor-operated by-pass valve by	ROCKWELL-REPUBLIC
15	Level controller by	ROCKWELL-REPUBLIC

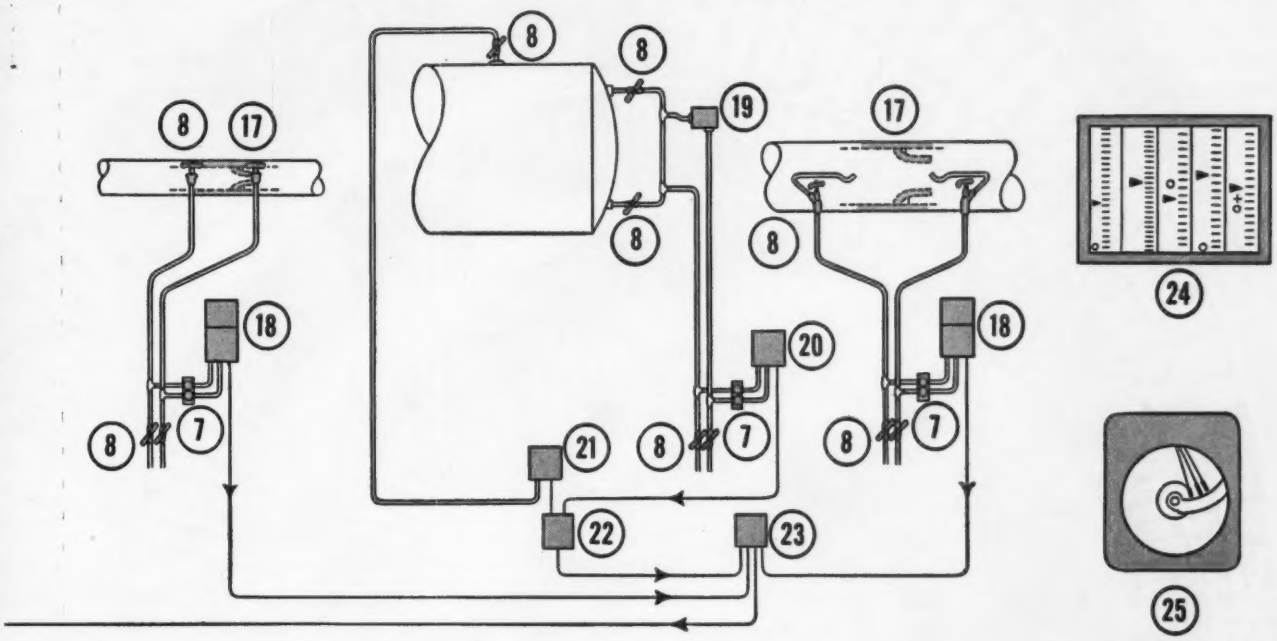
control system

FEEDWATER MEASUREMENT

TEMPERATURE COMPENSATED DRUM LEVEL MEASUREMENT

STEAM FLOW MEASUREMENT

INDICATING AND RECORDING WHERE REQ'D



package from one source:

16	Manual-automatic control station by	ROCKWELL-REPUBLIC
17	Nozzle flow sections by	ROCKWELL-REPUBLIC
18	Flow transmitter with square rooting by . .	ROCKWELL-REPUBLIC
19	Constant level reservoir by	ROCKWELL-REPUBLIC
20	Level transmitter by	ROCKWELL-REPUBLIC
21	Pressure transmitter by	ROCKWELL-REPUBLIC
22	Compensating relay by	ROCKWELL-REPUBLIC
23	Combining relay by	ROCKWELL-REPUBLIC
24	Gauges by	ROCKWELL-REPUBLIC
25	Recorders by	ROCKWELL-REPUBLIC

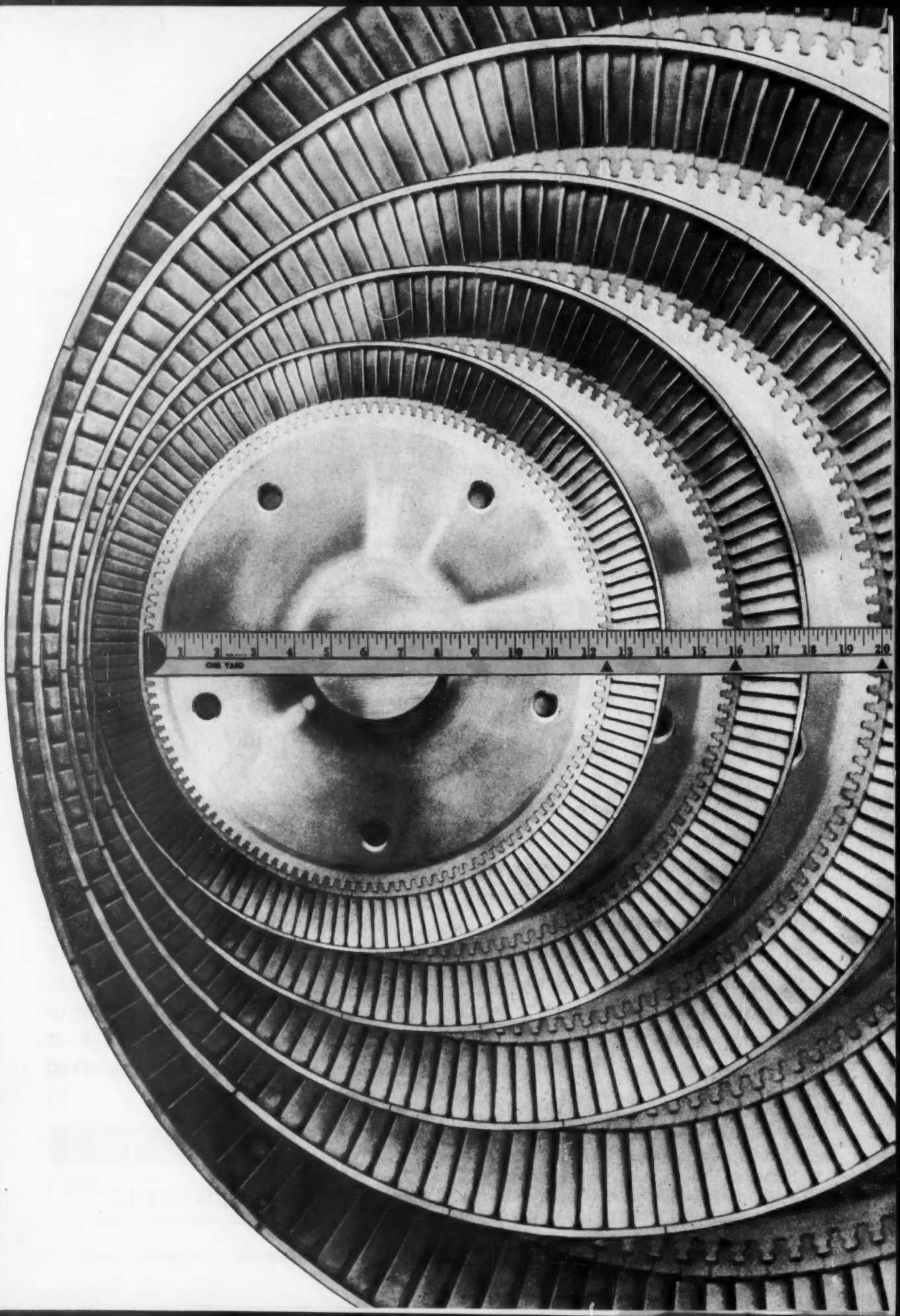
RF-24

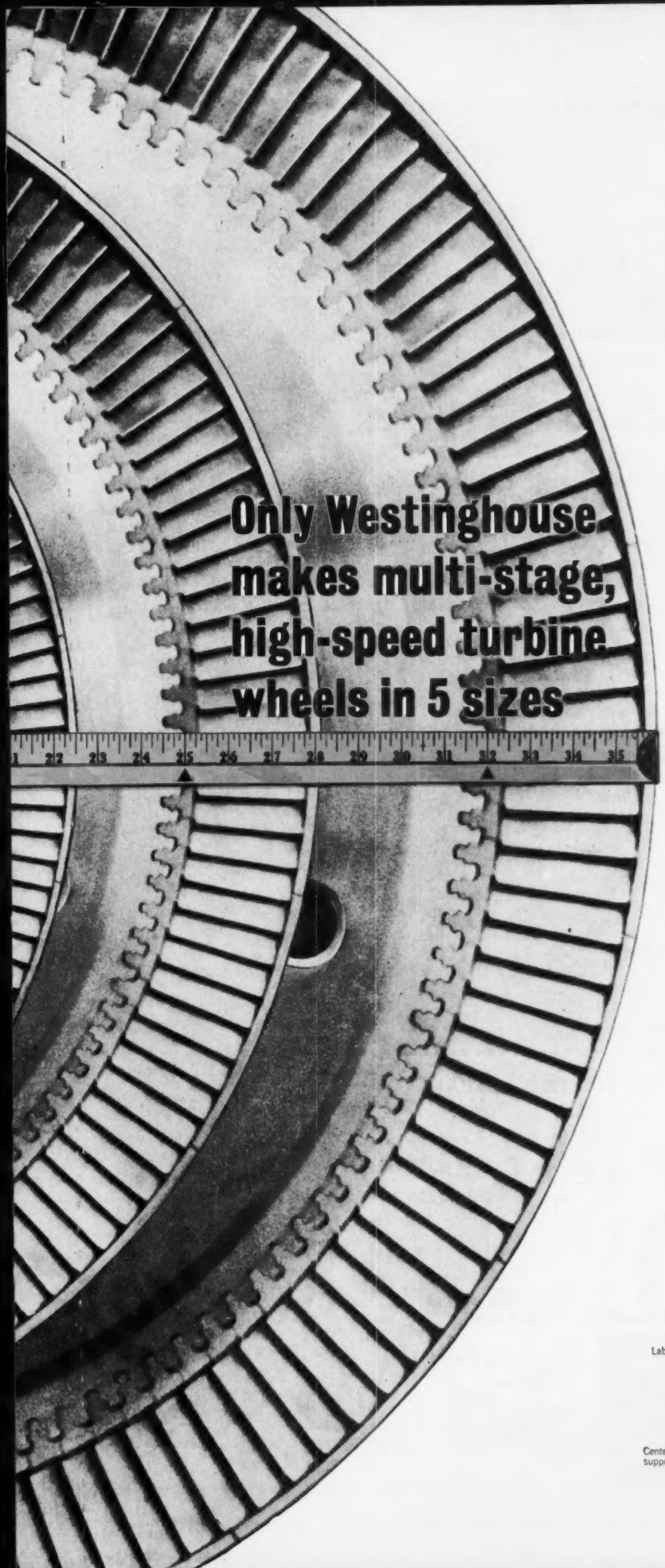
For full details on Rockwell-Republic boiler feedwater control systems, contact the Republic Engineer in your area. Or, write to Republic Flow Meters Company, Subsidiary of Rockwell Manufacturing Company, 2240 Diversey Parkway, Chicago 47, Illinois. In Canada: Republic Flow Meters Canada Ltd., Toronto.

REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by
ROCKWELL

For more facts circle 230 on Reader Service card, p 109

Circle 231 on Reader Service card for following ad ➤





FOR THE RIGHT SIZE TURBINE START WITH THE RIGHT SIZE WHEEL

Several things determine what size turbine will supply power within economic limitations . . . steam pressure and temperature, exhaust steam pressure, horsepower and speed requirements, cost of steam, and operating hours required for turbine pay-out.

To bring all these factors into as close a relationship as possible, Westinghouse high-speed M-line turbines are custom-engineered for each job. Yet they all follow one basic assembly method, using standardized components. Result . . . the reliable performance expected from a *standard* design, combined with the high efficiency expected from a *custom* design.

Determining the right wheel size is the first and key decision . . . and only Westinghouse makes high-speed turbine wheels in 5 sizes, 12½ through 32 inches. This wide range makes Westinghouse M-line turbines adaptable to any steam condition and speed up to 16,000 rpm, with capacities up to 32,000 hp and higher.

Wheels are installed on one of five different size turbine frames, selected to match wheel sizes. Then, according to job requirements, other standardized components are selected and added to the assembly.

Westinghouse M-line turbines have a number of exclusive features, such as modular type governors and serrated root blading. Check these five other features. You'll find them on all high-speed M-line turbines built by Westinghouse . . . world's most modern small turbine facility.

Oil relay governor, with package components. Specifically designed for high-speed service.

Multi-valve bar lift steam chest. Liberal volume. Special valve and seat design for maximum part load efficiency.

Centerline support of casing. Eliminates thermal misalignment.

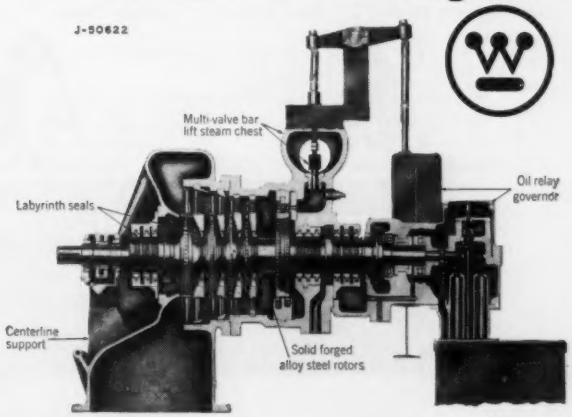
Solid forged alloy steel rotors for most applications. Critical speeds are well out of the operating range. Maximum operational dependability.

Labyrinth seals throughout. Eliminates maintenance and replacement required with rubbing type seals.

Send for new Descriptive Booklet B-8227 describing in detail the features of this new line of turbines. Write to Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa.

You can be sure . . . if it's **Westinghouse**

J-50622



HOFFMAN

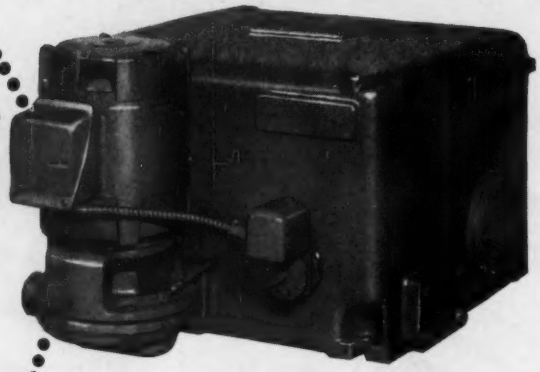
CENTRIFUGAL-TYPE

PUMPS

Unequalled Quality

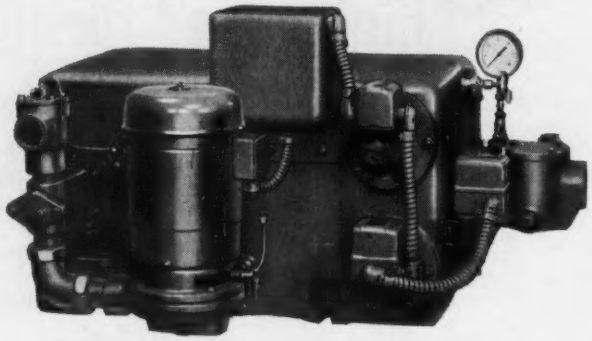
Your Best Buy

CONDENSATION TYPE "HCS" SINGLE UNIT



Single and Duplex Units
Capacities through 150,000 sq. ft. E.D.R.
Featuring compact, Centrifugal Pump Design

VACUUM TYPE "HVS" SINGLE UNIT



Single and Duplex Units
Capacities through 100,000 sq. ft. E.D.R.
Featuring Hoffman Jet Vacuum Producer

Thousands of industrial and commercial steam systems use Hoffman Centrifugal Type Pumps year after year for rapid, low-cost removal of condensate and air from steam lines, and return of condensate to the boiler. Efficient Hoffman Pumps, with all bronze fittings and cast iron receivers, are designed so that all parts subject to wear can be easily inspected, serviced or replaced without disturbing piping. For small systems, Hoffman's line of quality-engineered "Watchman" Condensation Pumps have ratings up to 12,000 sq. ft. E.D.R. Hoffman sales-engineers are available at all times for consultation.

HOFFMAN COMPLETE LINE OF SPECIALTIES...STEAM AND WATER

Radiator Vents

Main Vents

Radiator Traps

F&T Traps

Union Ells

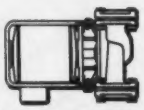
Bucket Traps

Pressure Reducing Valves

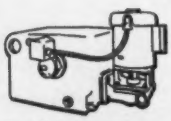
Strainers

Temperature Regulators

Vacuum Breakers


Hot Water Circulators

Float Valves

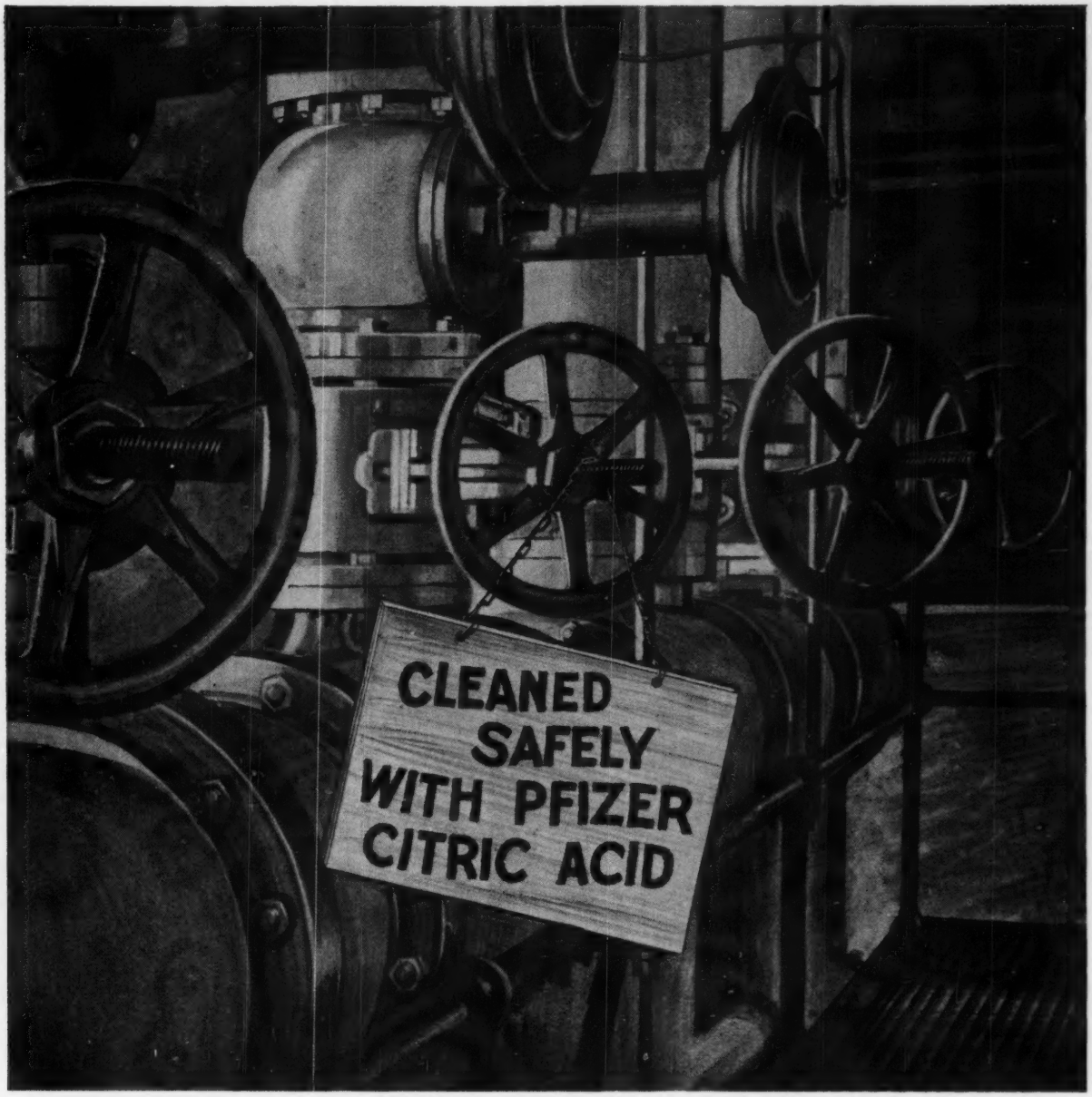

Condensation Pumps

Flow Control Valves

Zonal Valves

HOFFMAN SPECIALTY MFG. CORP.
1700 W. 10TH STREET
INDIANAPOLIS 7, INDIANA
VALVES • TRAPS • PUMPS • STRAINERS • REGULATORS

For more facts circle 232 on Reader Service card, p 109



HEAT EXCHANGERS—ATOMIC REACTORS—CHEMICAL PROCESSING EQUIPMENT

Safe, efficient cleaning of stainless steel boilers, heat exchangers, atomic reactors, chemical processing equipment! It's assured, when chloride-free Pfizer Citric Acid is used by your chemical cleaning service company. Easier and more efficient after-rinsing is another definite plus! Check for yourself these unique advantages of using Pfizer Citric Acid:

1. Citric acid is highly efficient in removing imbedded metal and oxide films from stainless steel.
2. Citric acid's excellent sequestering ability prevents reprecipitation of dissolved scale.
3. Citric acid cleaning completely eliminates the possibility of chloride stress corrosion.
4. Citric acid can be effectively inhibited without losing its cleaning or sequestering ability.
5. Citric acid is sold as a dry, 100% acid—meaning savings in storage and handling.
6. Citric acid is water soluble, easy to handle, and non-toxic.

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For further information, mail this coupon to Pfizer today.

I want to learn more about the use of Pfizer Citric Acid for cleaning stainless steel equipment. Please send me Technical Bulletin 102.

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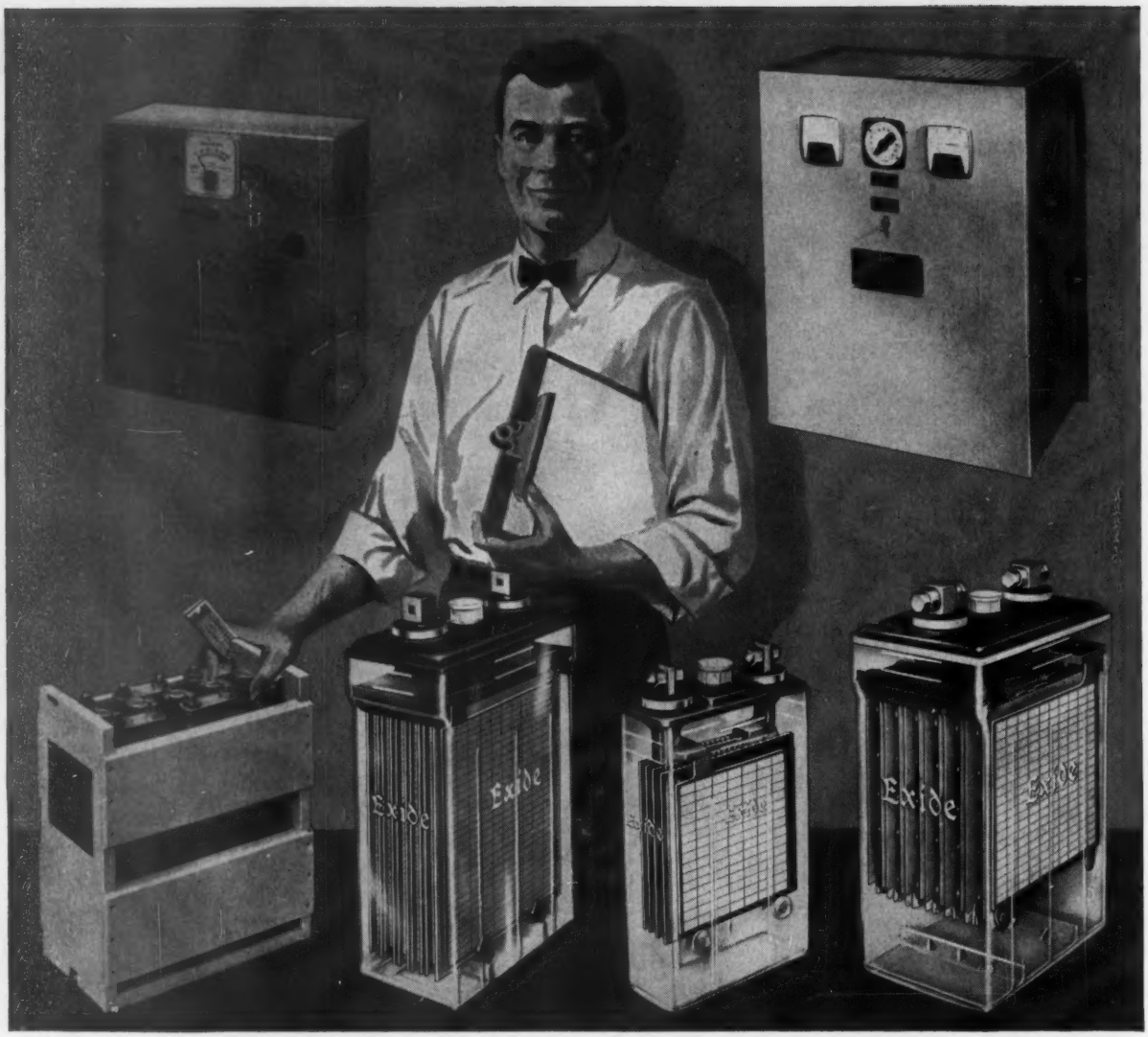
Chas. Pfizer & Co., Inc., Chemical Sales Div., 630 Flushing Ave., Bklyn. 6, N.Y. Branch Offices: Clifton, N.J.; Chicago, Ill.; San Francisco, Cal.; Vernon, Cal.; Atlanta, Ga.; Dallas, Tex.; Montreal, Can.

For more facts circle 233 on Reader Service card, p 109



Exide determines the best battery type and charger for you by studying your particular duty requirements

Selecting a battery and charger today is really an engineering job. Each application has its own requirements. That's why Exide offers a variety of batteries and chargers—in fact the broadest in the field. It means you can buy the type battery and charger you should have. Because Exide has no ax to grind for any particular type, you can expect an unbiased recommendation.

The battery line includes (1) flat plate Tytex with Silvium;* (2) flat plate Tytex with calcium; (3) long-life Exide-Manchex—Planté type—with Silvium; (4) low-maintenance pocket positive nickel-cadmium; (5) new 20-year Exide-Ironclad tubular with Silvium. The charger line includes (1) constant voltage type; (2) trickle or Hi-Lo type. You get Exide quality and value on all.

An Exide power package lets you buy with confidence. Exide service—the quickest, most dependable you can get—covers battery and charger. For complete information, write Exide Industrial Marketing Division, The Electric Storage Battery Company, Philadelphia 20, Pa.

*Silvium is Exide's patented corrosion-resistant grid alloy

Exide®

INDUSTRIAL MARKETING DIVISION (ESB)
The Electric Storage Battery Company

For more facts circle 234 on Reader Service card, p 109
Circle 235 on Reader Service card, p 109➤

STYLE 804
BRAIDED ASBESTOS, MONEL
Asbestos graphite
Carbonite plastic core
Temperatures to 800° F.

STYLE 806
GRAPHITE COATED
Monel-inserted asbestos over
Carbonite plastic core
Temperatures to 1000° F.

STYLE 807
NON-GRAPHITED
Monel-inserted asbestos over
Carbonite plastic core
Temperatures to 1000° F.

STYLE 809
GRAPHITE COATED
Inconel-inserted asbestos over
Carbonite plastic core
Temperatures to 1250° F.

STYLE 810
NON-GRAPHITED
Inconel-inserted asbestos over
Carbonite plastic core
Temperatures to 1250° F.

Look at the specs . . . and you will select

ANKORITE

High Pressure, High Temperature

PACKINGS

The Anchor Packing Company—with more than 50 years experience in the mechanical packing industry—specializes in designing the packing for the application. That is one reason why Anchor packings are always efficient, more effective and longer lasting.

Here's an example: Displayed in cross section are five ring and coil packings, all specially fabricated to give long service in high pressure, high temperature applications. Styles 806, 807, 809 and 810 are ideal in valve stems and expansion joints for super-heated steam, hot gases and hot oils. Style 804 stays soft against high pressures and temperatures . . . is unsurpassed in control valves, throttle valves, autoclaves and similar services.

If you have a packing problem, see your local Anchor Representative. He will gladly assist you. Or, contact the Anchor General Office. Write for our new catalog.

Find it Fast in The "Yellow Pages"

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THE ANCHOR PACKING COMPANY

GENERAL OFFICES PHILADELPHIA, PENNSYLVANIA
FACTORIES MANHEIM, PA., ELKHART, IND., MONTREAL, CAN.

● FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

Six marked differences make Elliott turbines a better buy

Why are Elliott YR turbines your best choice for mechanical drives? Some of the reasons are described on the opposite page. These are tangible reasons why you can expect dependable, economical operation with little care or attention.

With more than 50 years' experience in mechanical-drive turbines up to 50,000 hp; with the most complete line of field-proven machines; with engineering and service facilities nationwide: Elliott is clearly "Turbine Headquarters." Write for bulletin H22-D.

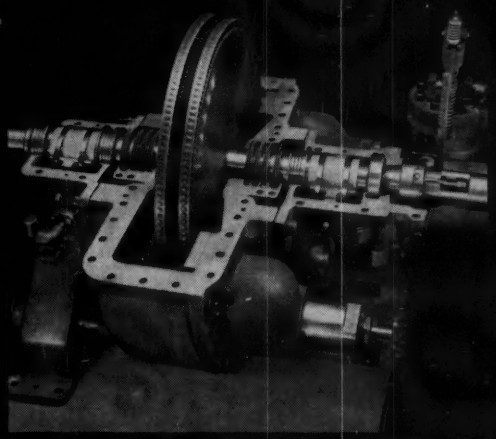
day-in/day-out

ELLIOTT COMPANY

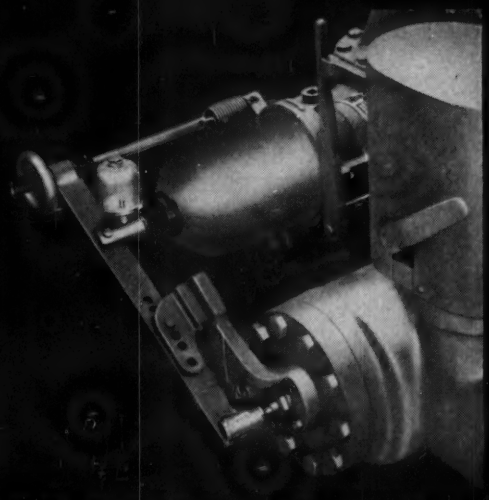
GENERAL OFFICES: JEANNETTE, PENNSYLVANIA
PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio
TURBINES • GENERATORS • MOTORS • COMPRESSORS
TURBOCHARGERS • EJECTORS • STRAINERS • TUBE CLEANERS

H1-1

For more facts circle 236 on Reader Service card, p 109



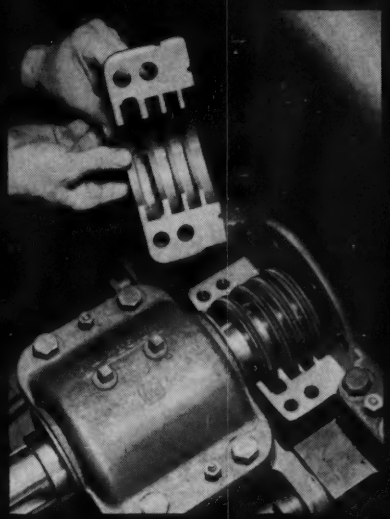
Precise alignment of shaft, through true centerline support, permits smooth and dependable operation at all operating temperatures.



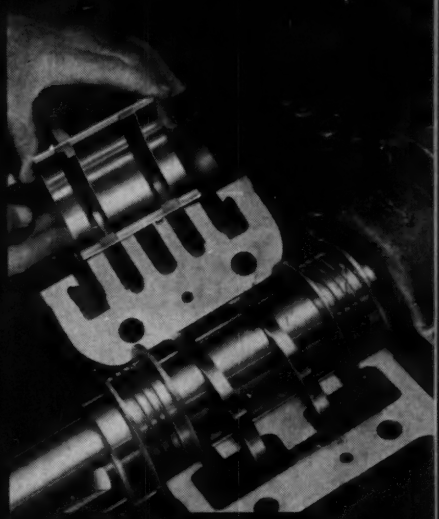
Simple, positive direct-acting speed-governing system is dependable, weather-proof, accurate. Separate trip gives positive overspeed protection.

These features mean dependable, economical turbine operation:

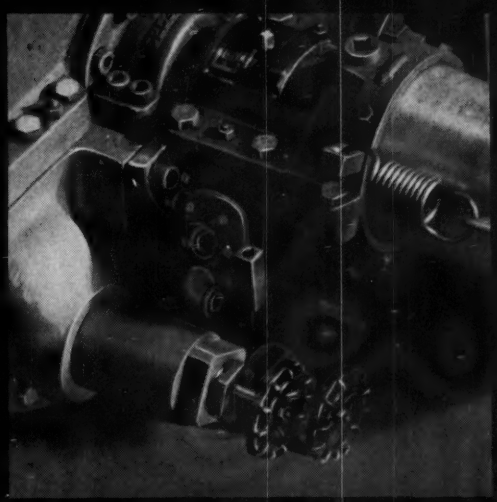
1. True centerline support
2. Positive speed control
3. Accaccessible shaft seals
4. Inexpensive bearings
5. Optional hand valve
6. Full protection



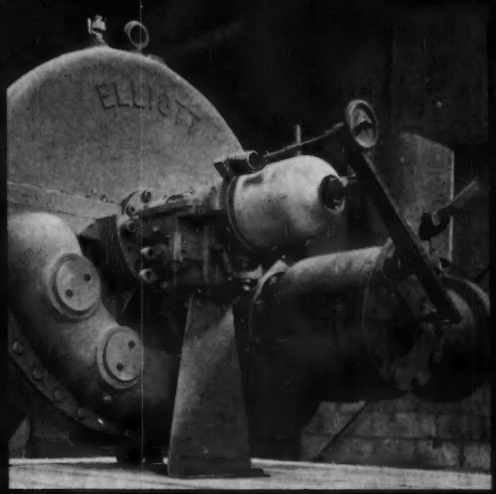
Accessible shaft-seals simplify maintenance and routine inspection. Covers readily removed without disturbing casing.



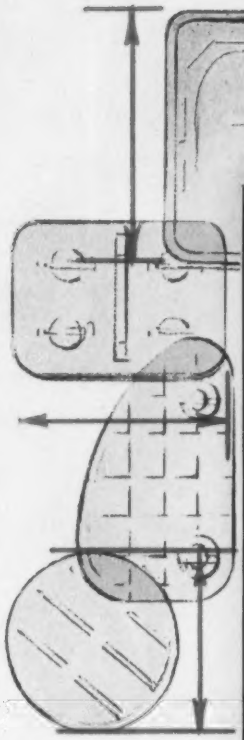
Inexpensive liner-type bearings readily installed with no scraping, fitting or adjustment required.



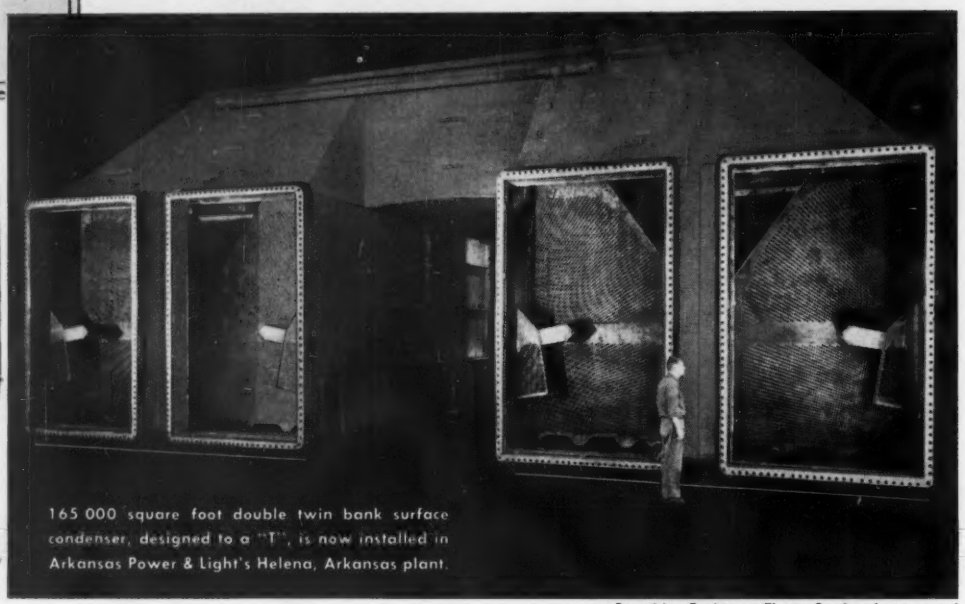
Steam-saving hand valve with pilot, which can be opened against full steam pressure, reduces steam consumption at partial loads.



All-weather protection is standard for Elliott YR turbines. They shrug off heat, snow, moisture, dust or contaminated atmosphere.



YUBA CONDENSERS
ANY SIZE . . . ANY ARRANGEMENT



165 000 square foot double twin bank surface condenser, designed to a "T", is now installed in Arkansas Power & Light's Helena, Arkansas plant.

Consulting Engineers: Ebasco Services Incorporated

MOST VERSATILE TUBE BANK LAYOUT IN THE INDUSTRY

YUBA SURFACE CONDENSER DESIGN . . . most flexible . . . any size . . . any arrangement. Through design advances such as those incorporated in the unit above, Yuba illustrates the concepts you can expect from years of engineering leadership in the power industry.

Yuba's twin-bank tube layout, seen here in a two shell "T" type installation, promotes unobstructed, equally distributed flow. Through Yuba's patented design, the condensate can be deaerated with oxygen content guaranteed to be less than 0.005 cc per liter.

As a design extra, Yuba staggers the tube support plates – reducing harmonics – eliminating vibration. These are some of the reasons why Yuba surface condensers of all sizes have been installed in plants throughout the world. You'll want to know more about the most versatile tube bank layout in the industry – contact Yuba today.

Other Yuba products for steam power plants include feedwater heaters, evaporators, expansion joints, cranes, tanks, structural steel erection, and scores of other items.

YUBA

specialists in power plant equipment

YUBA HEAT TRANSFER CORPORATION

Tulsa, Oklahoma
Plants in Tulsa and Honesdale, Pa.

YUBA CONSOLIDATED INDUSTRIES, INC.

Sales Offices in Principal Cities

For more facts circle 237 on Reader Service card, p 109

IF YOU WANT SUPERIOR PRECIPITATOR PERFORMANCE

A precipitator is a lifetime purchase. Once it is installed, you must live with it, whether you like its habits or not. Because of that Buell urges you to look for the following features when you are making the major investment represented by an electric precipitator.

CONSTRUCTION

1. Custom designed, flexible—Buell helps you determine your precipitator needs, then designs a unit specifically for your requirements. Since Buell SF Precipitator sizes change by only 16" increments, you can get exactly the size you need, without compromise of size, space, and cost.

2. Simplified erection—Modern construction and assembly-marked components and a design that facilitates simple installation, make Buell SF Precipitators easy to erect without specialized contractors. Erection is supervised by Buell engineers, to ensure satisfactory operation.

3. Rugged construction—Simple, rugged construction gives you high efficiency, combined with negligible maintenance costs.

GAS FLOW

4. Uniform gas distribution—Buell designs the entire gas system for its precipitators—including connecting flues with adjustable turning vanes if needed. In addition, at the inlet, special field-adjusting baffles ensure uniform flow across the entire face of the unit. Buell has complete laboratory facilities to determine dust or gas flow pattern with specially constructed three dimensional precipitator models.

ELECTRICAL SYSTEM

5. Fool-proof power supply—Buell silicon rectifiers are compact, lightweight, highly efficient. They need no maintenance—another reason for the top performance of a Buell SF Precipitator.

6. Rigid suspension—The emitting frame of a Buell SF Precipitator is hung from four temperature and shock resistant quartz insulators, each sealed in an individual heated compartment. With this rigid system, electrical distance from emitting to collecting electrode is held constant. This produces uniformly high emission for peak efficiency.

7. Peak emission—Exclusive Spiralectrode® emitting electrodes are fixed top and bottom to the emitting frame. Self-tensioned and permanently aligned, they present areas of maximum emission per unit of power input. Top emission can be maintained with maximum applied voltage, because Spiralectrodes eliminate misalignment.

8. Minimum maintenance—The common maintenance headache in most precipitators is frequent replacement of emitting electrodes. Because of rugged suspension and patented electrode design, Buell's 10-year replacement record in this critical area is under 2%.

RAPPING

9. Effective rapping—avoids reentrainment—Buell mechanically raps one row of electrodes at a time, in a continuous cycle. Special pockets in collecting electrodes, and section-by-section rapping in the direction of gas flow, ensure against reentrainment.

You're sure to be pleased with the superior performance and minimum maintenance you'll get with a Buell SF Precipitator! Buell Engineering Co., Inc., Dept. 50-I, 123 William St., New York 38, N. Y. electric precipitators · cyclones · bag collectors · combination systems · classifiers. **Member Industrial Gas Cleaning Institute**

buell Norblo

Wheels that turn Ore into Steel... Coal into Kilowatts

Nearly half-a-million iron wheels, on more than 61,000 N&W coal cars, roll night and day. Shouldering big loads of top-quality, all-purpose coals from modern mechanized mines. Speeding coal to steel mills, electric utilities, and thousands of hungry furnaces in America and overseas.

N&W wheels are hustled to their destinations by the industry's newest fleet of diesel locomotives. They ride over one of the nation's finest roadbeds . . . are checked by electronic hot-box detectors . . . examined for possible flaws by ultra-sonic devices in N&W shops. And thousands of new wheels support the N&W's new roller bearing 85-ton king-size coal hoppers, the first and largest on any U. S. railroad.

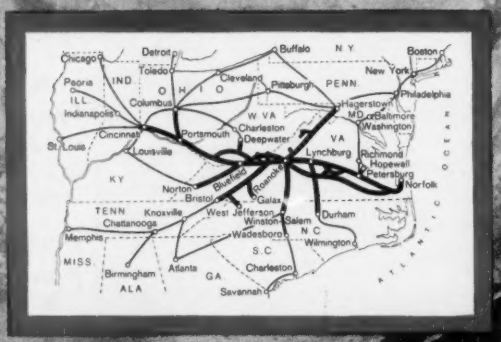
Put the N&W's swiftly-turning wheels to work for your business. You'll be sure of a superior variety of coals from the many up-to-date mines along the N&W . . . of fast dependable service from a carrier with modern equipment and 78 years of coal-hauling experience. And you'll be dealing with a leader, one of the nation's major coal carriers. Get the full story on N&W coals at any of our coal traffic offices.

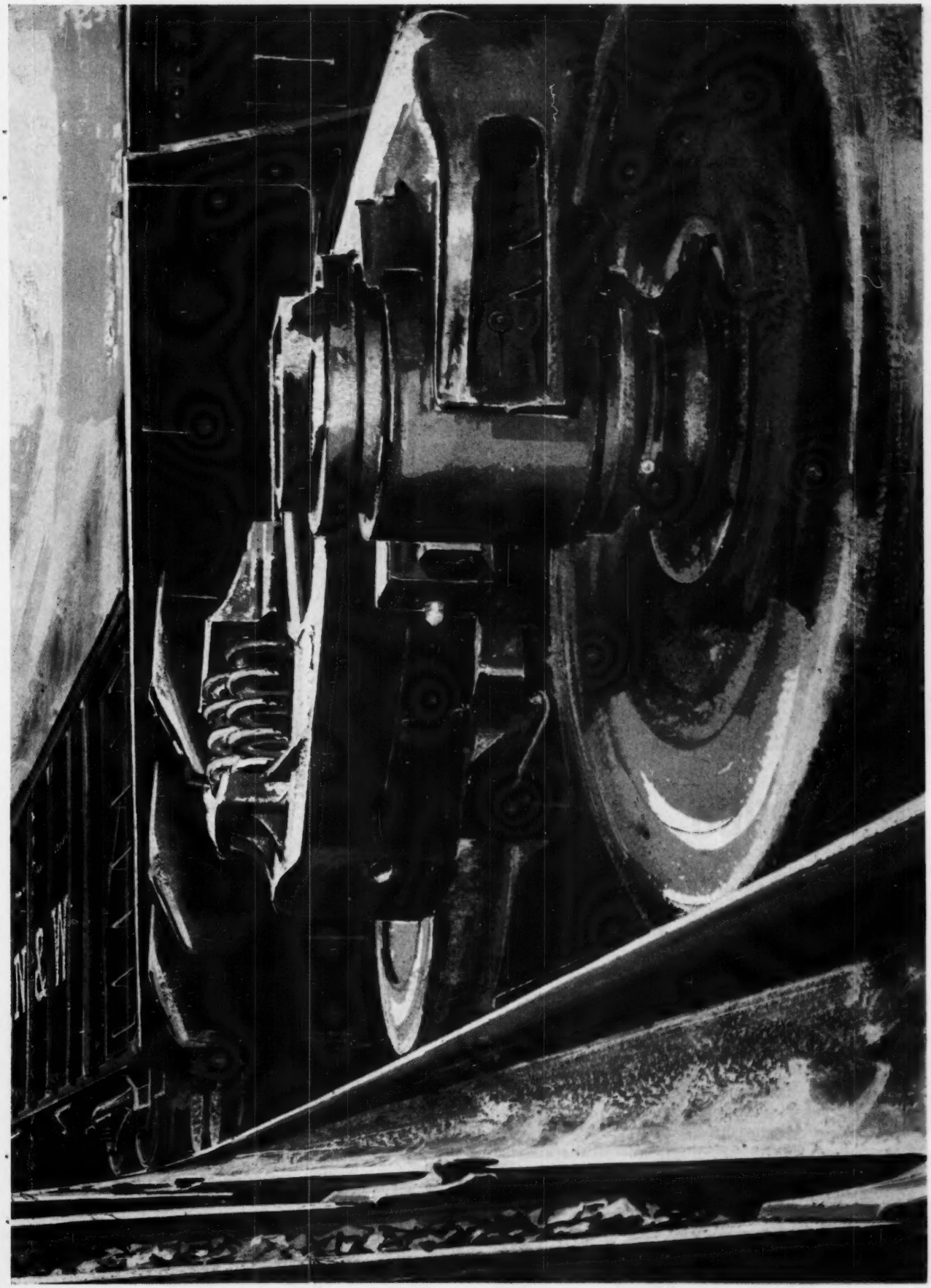
N&W

Nation's Going-est Railroad

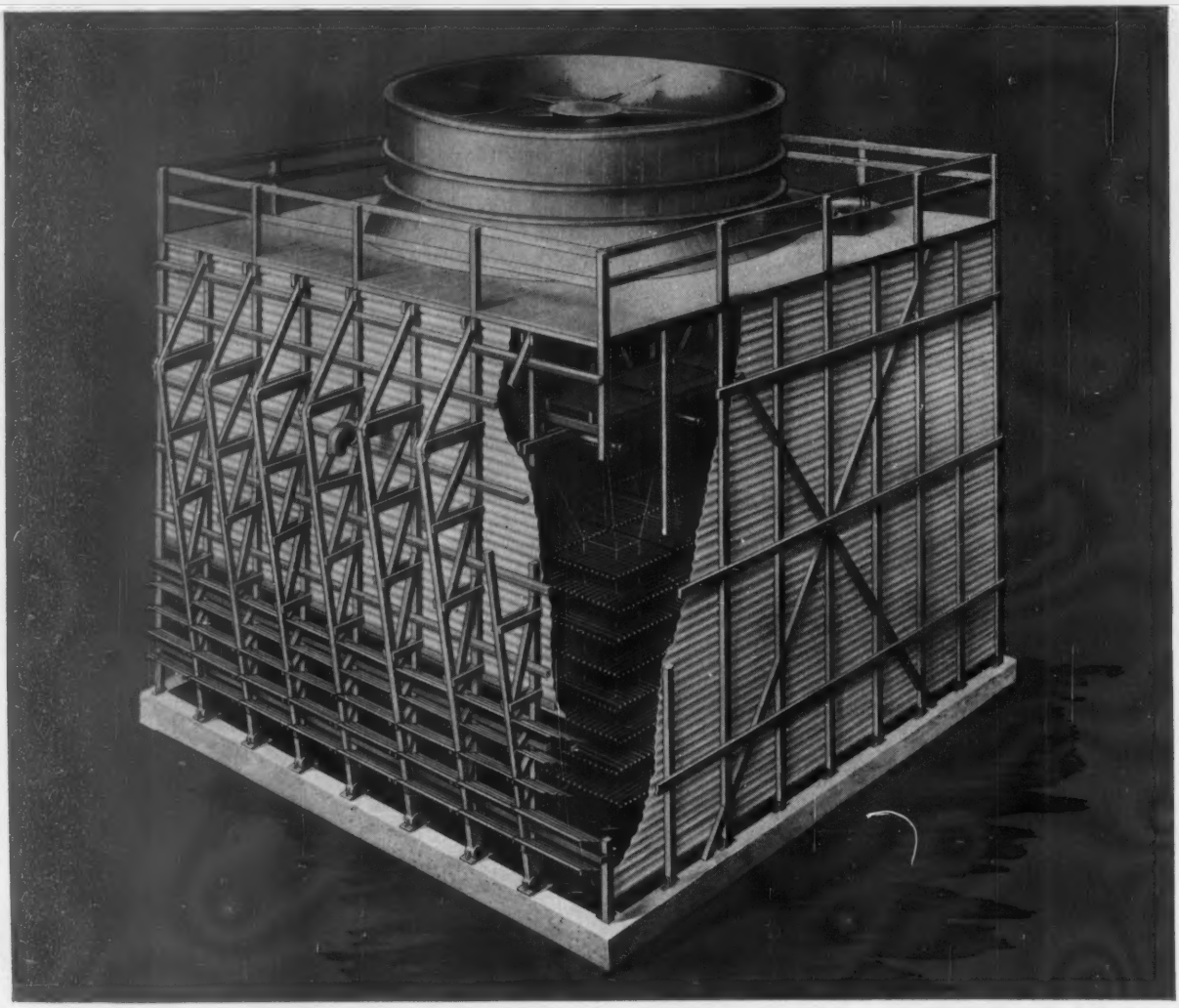
NORFOLK and WESTERN RAILWAY

GENERAL OFFICES • ROANOKE, VA.





For more facts circle 239 on Reader Service card, p 109



New idea...no structural internals

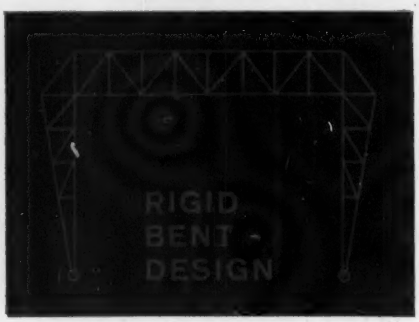
The *interior* of this new Foster Wheeler cooling tower is *completely free of structurals* below the roof trusses.

It is Foster Wheeler's new Rigid-Bent design featuring tapered built-up columns outside the tower sheathing, away from the moist, corrosive atmosphere within.

In every application, particularly where water chemistry and biological attack are serious problems, the FW Rigid-Bent design offers . . . isolation of vertical structurals from corrosion and biological attack . . . and uncommon ease of inspection, maintenance and replacement of all parts.

Space requirements and operational characteristics are the same as those attainable with older designs. Increased capacity by the addition of cells is no problem. Structurals are easily inspected and repaired during tower operation.

If you are currently considering an installation, let us provide you with further information. Write to Dept. CT, Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.

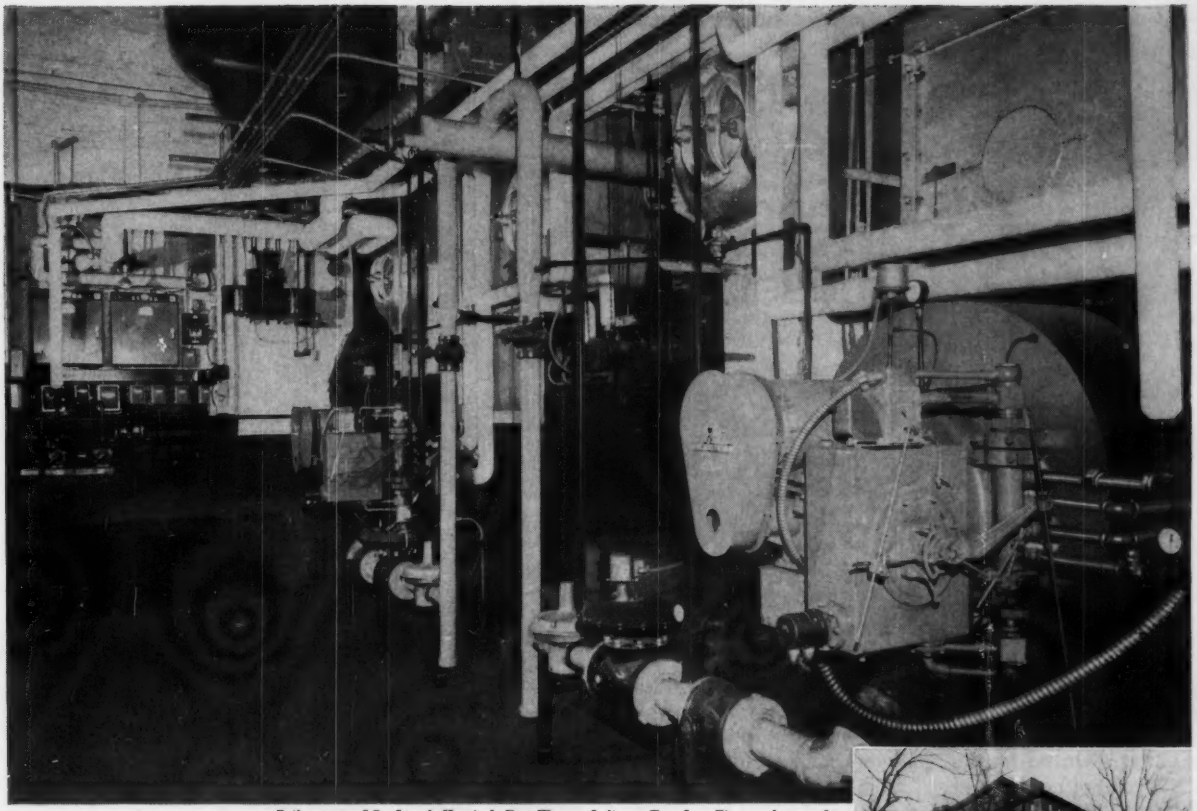


All tower internals are suspended from roof trusses. Cable-hung fill racks are quickly lowered to ground level for inspection and maintenance.

FOSTER WHEELER

NEW YORK TORONTO LONDON PARIS MILAN TOKYO

For more facts circle 240 on Reader Service card, p 109



Boiler room of St. Joseph Hospital, Fort Wayne, Indiana. Two Iron Fireman burners fire gas or residual oil in water tube boilers. Installation by Superior Fuel Co., Fort Wayne.

The modernization of the boiler plant is part of a $4,500,000 expansion program now under way at Fort Wayne's St. Joseph Hospital (Poor Handmaids of Jesus Christ). A new nine-story building will replace several of the older structures and add 150 beds.

Ability to fire either gas or oil cuts hospital heating costs

Low cost residual oil in winter — low gas rates in summer

From March to December the St. Joseph Hospital, Fort Wayne, Indiana, fires its boilers with gas because gas rates are low during these months. In winter, during peak gas demand and higher rates, the plant switches to residual oil—the heavy fuel oil that combines low cost with high heat value. Operating costs have been cut during both periods, according to Mr. Neal W. Bouse, Chief Engineer.

Switching fuels is no chore. It can be done quickly and easily—the Iron Fireman gas-oil burner fires either fuel. In many instances savings are made by transferring fuels daily rather than seasonally to relieve the gas lines during daily peaks. Fuel transfer can be done manually or automatically.

Many other advantages are listed by Mr. Bouse, such as cleanliness (both inside and outside the hospital), space and labor saving, faster recovery rate and much lower maintenance costs.

Please mail coupon for full information and specifications.

IRON FIREMAN

HEATING AND AIR CONDITIONING
AIRCRAFT COMPONENTS AND EQUIPMENT
MISSILE AND AIRCRAFT GYROSCOPES
ELECTRONIC EQUIPMENT
CONTROL INSTRUMENTS

Iron Fireman Mfg. Co., 3158 W. 106th St., Cleveland 11, Ohio
(In Canada, 80 Ward St., Toronto)

Please send full information and specifications on Iron Fireman gas-oil firing.

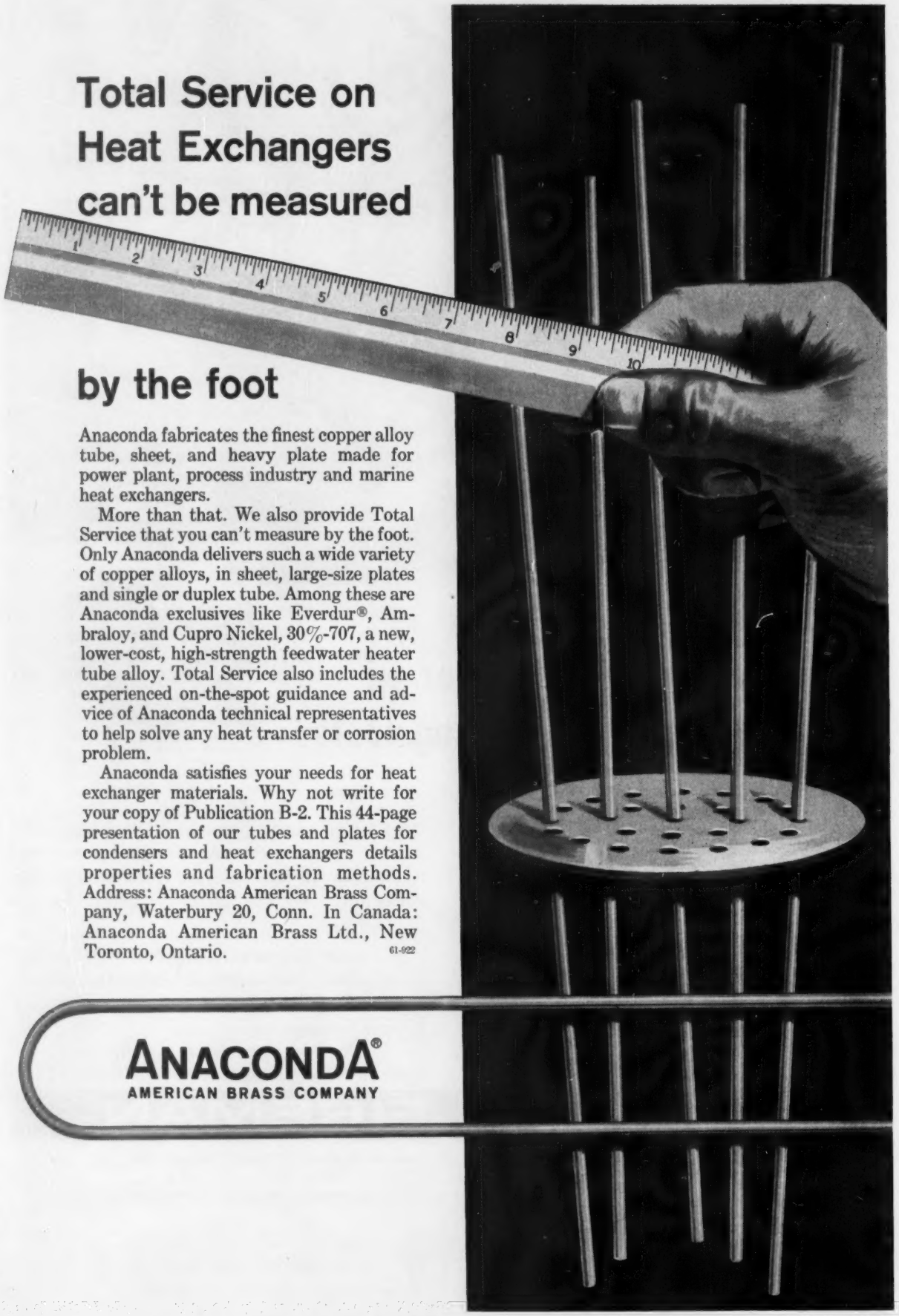
Name_____

Address_____

City_____ State or Prov._____

For more facts circle 241 on Reader Service card, p 109

Total Service on Heat Exchangers can't be measured by the foot



Anaconda fabricates the finest copper alloy tube, sheet, and heavy plate made for power plant, process industry and marine heat exchangers.

More than that. We also provide Total Service that you can't measure by the foot. Only Anaconda delivers such a wide variety of copper alloys, in sheet, large-size plates and single or duplex tube. Among these are Anaconda exclusives like Everdur®, Ambraloy, and Cupro Nickel, 30%-707, a new, lower-cost, high-strength feedwater heater tube alloy. Total Service also includes the experienced on-the-spot guidance and advice of Anaconda technical representatives to help solve any heat transfer or corrosion problem.

Anaconda satisfies your needs for heat exchanger materials. Why not write for your copy of Publication B-2. This 44-page presentation of our tubes and plates for condensers and heat exchangers details properties and fabrication methods. Address: Anaconda American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 61-922

ANACONDA®
AMERICAN BRASS COMPANY

CASTABLE FURNACE LININGS

The speed and ease with which refractory linings can be installed with Harbison-Walker castable refractories have resulted in savings of thousands of dollars in furnace construction. H-W castables have excellent dimensional stability, have low permeability and thermal conductivity, and are resistant to spalling and abrasion.

Harbison-Walker has available a *complete* range of castables—from very light insulation to heavy slag-and-abrasion-resistant types—to meet virtually any service requirement.

SAVE TIME AND MONEY

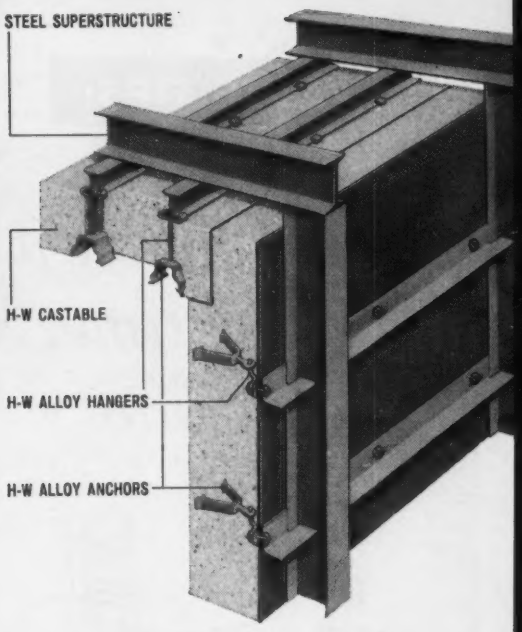
PROPER ANCHORING—KEY TO MAXIMUM SERVICE LIFE

Getting the optimum service life from monolithic structures more often than not depends on proper anchoring or reinforcement. Harbison-Walker has developed a whole series of high temperature metal and refractory anchoring systems to assure proper castable construction. *Complete* technical service is available. Write for details.

HARBISON-WALKER REFRACTORIES COMPANY

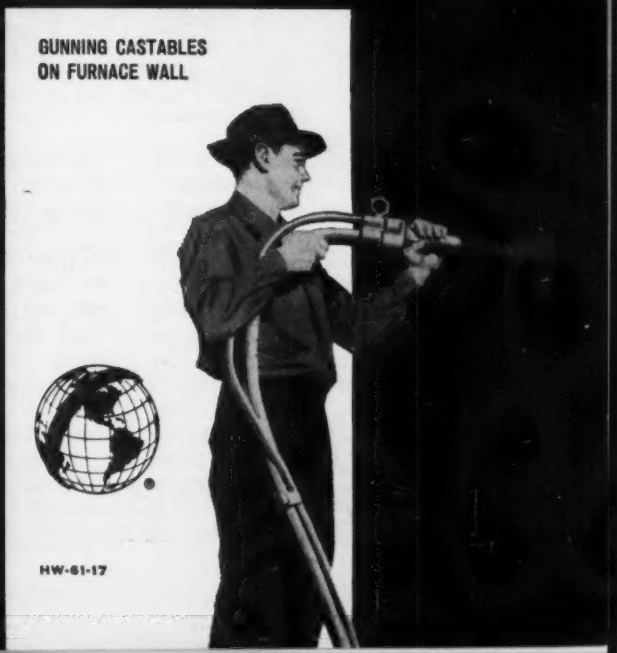
AND SUBSIDIARIES • GENERAL OFFICES: PITTSBURGH 22, PA.

World's Most Complete Refractories Service



A TYPICAL ARCH AND SIDEWALL CONSTRUCTION UTILIZING HARBISON-WALKER CASTABLE REFRACTORIES

EASY TO MIX
EASY TO USE

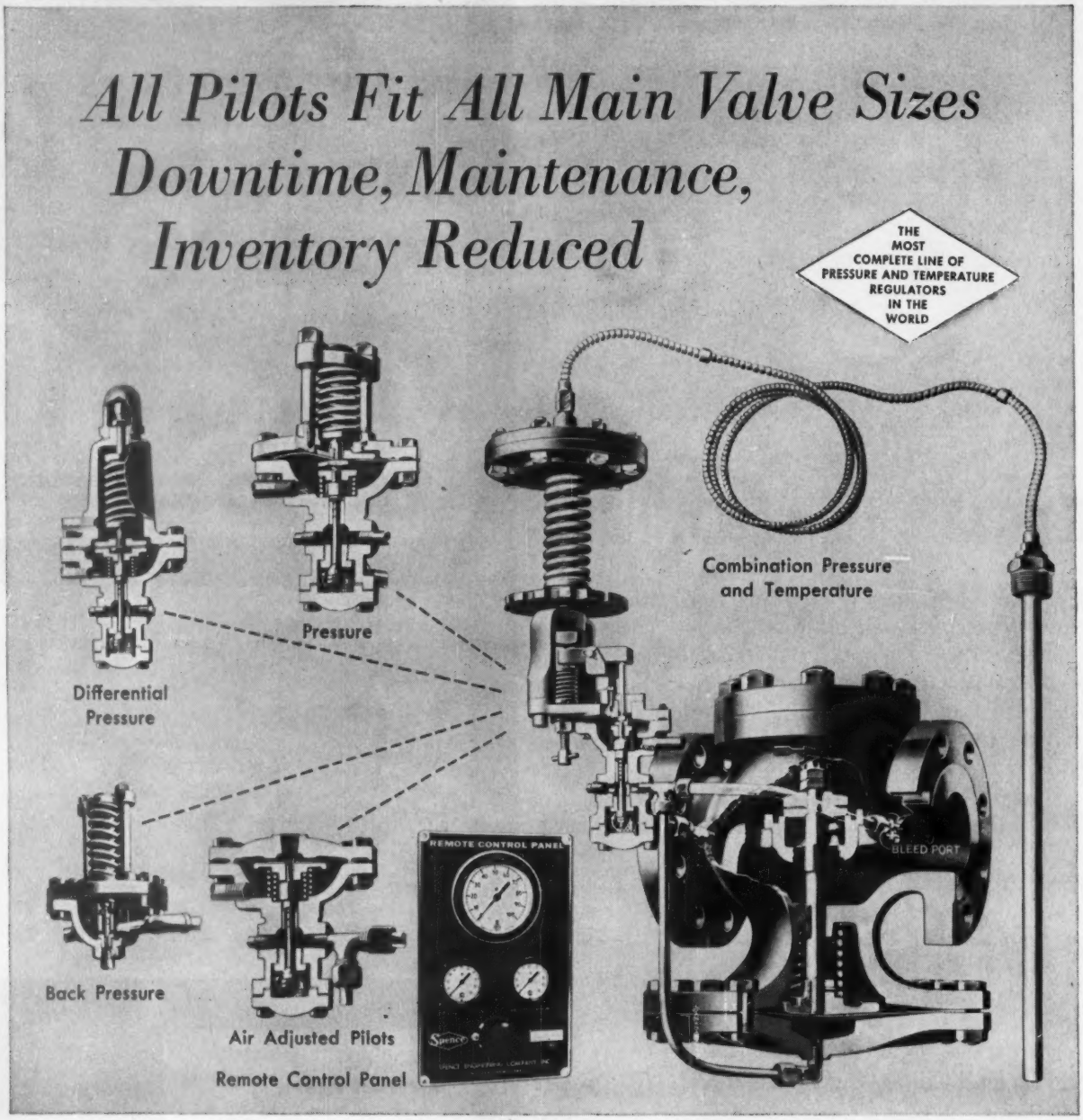


GUNNING CASTABLES ON FURNACE WALL

HW-61-17

VALVE TIPS:

All Pilots Fit All Main Valve Sizes Downtime, Maintenance, Inventory Reduced



Let's start off by admitting there's no such thing as a "maintenance-free" regulating valve. Any valve that automatically controls temperatures or pressures within close limits can be affected by dirt in steam lines.

If trouble does develop, engineers want a regulator they can get back on the line — fast. That's one reason why more engineers are standardizing on Spence Regulating Valves with externally mounted pilots. The simple test of disconnecting the external bends establishes whether the trouble is in the main valve or the pilot.

If the main valve is the trouble spot, it can be maintained without removing the valve body from the line. If the pilot is the trouble spot, it is easily removed for cleaning. However, if production downtime is a strong factor, the fastest method is to install a spare pilot and it is inexpensive.

All Spence pilots fit all sizes of Spence main valves. If you have twenty pressure regulators, for instance, all you need is *one spare pilot*. It will fit all main valve sizes from ¼" to 12".

Another advantage of the Spence design is the external pilot is interchangeable. You can change the function of a regulator by merely changing the pilot. In many plants this can represent an important factor in reduced inventory costs because you only carry a few inexpensive extra pilots instead of complete regulators. Obviously, there is also a considerable savings in labor costs when a valve can be converted, in the line, from a temperature regulator to any one of various pressure regulators.

The pictures above show a few of Spence's wide line of automatic regulators. For more information write for Bulletin TE.

SPENCE ENGINEERING COMPANY, INC.
Walden 1, New York

SE-145

For more facts circle 244 on Reader Service card, p 109

Adding new dimensions — *to engineering*

Ingersoll-Rand twin-shell steam condenser with 500,000 sq. ft. of surface integrated with a large capacity dual side exhaust turbine.

Are you thinking big in kilowatt capacity? We are!

That's right! We're thinking in terms of tomorrow's "super capacity" generating units, and how our steam condensers will best fit into the shape of things to come. We're studying ways to further optimize steam flow paths... to reduce water requirements... to minimize space needed for installation. In short, *we're thinking big to build them smaller* — to provide the power industry with the highest performing and the most compact steam condensers for any type and size of generating unit.

PUMPS • CONDENSERS • EJECTORS & VACUUM PUMPS
AIR & ELECTRIC TOOLS • AIR COMPRESSORS

Ingersoll-Rand
11 Broadway, New York 4, N.Y.

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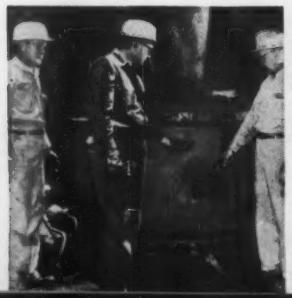
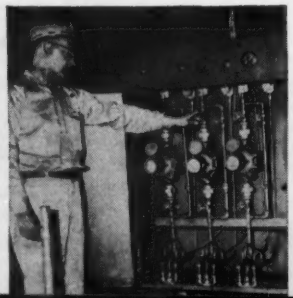
ANOTHER

EASTERN CLEANING PLANT NEARS COMPLETION

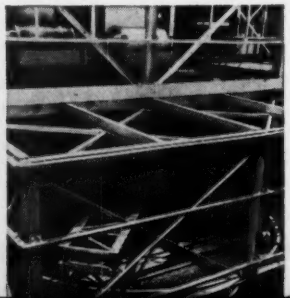
This centrifugal dryer is one of the methods used at Keystone to control moisture.



Maintenance foreman adjusts control panel of the automatic oil treating machine.



Magnetite is thickened here before being returned to the heavy media washer.



Heavy media washer cleans the coarse coal—effectively reduces ash.

The expansion of the coal cleaning plant at Eastern Gas and Fuel Associates' Keystone mine located in McDowell County, West Virginia, has reached the point where much of the new equipment is already in test operation.

The additional facilities at Keystone will include heavy media washers, a heavy media cyclone, froth flotation cells with their associated filtering equipment, and low-head drain and rinse screens, with centrifugal drying facilities. These additions permit Keystone to provide the best low volatile coals available today.

Designed by Eastern's own engineering staff, the Keystone plant is the second in a series of new or modernized coal cleaning plants now under construction. Another similar project is in the planning stage.

These plants are evidence of Eastern's determination to continually improve their product and their service to customers. Call any Eastern Representative for information on the wide variety of Eastern coals.

Eastern Coals and Eastern Customer Service can help you conserve your fuel dollars.

EASTERN GAS AND FUEL ASSOCIATES

BOSTON • BUFFALO • CINCINNATI • CLEVELAND • DETROIT • NEW YORK
NORFOLK • PHILADELPHIA • PITTSBURGH • SYRACUSE

EASTERN GAS AND FUEL ASSOCIATES — BEACON COAL

For more facts circle 246 on Reader Service card, p 109

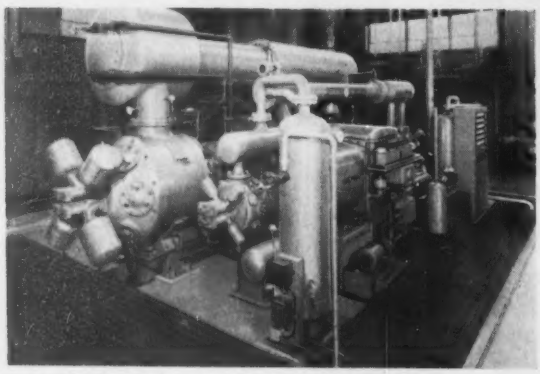
experience and attention to detail

...your assurance of

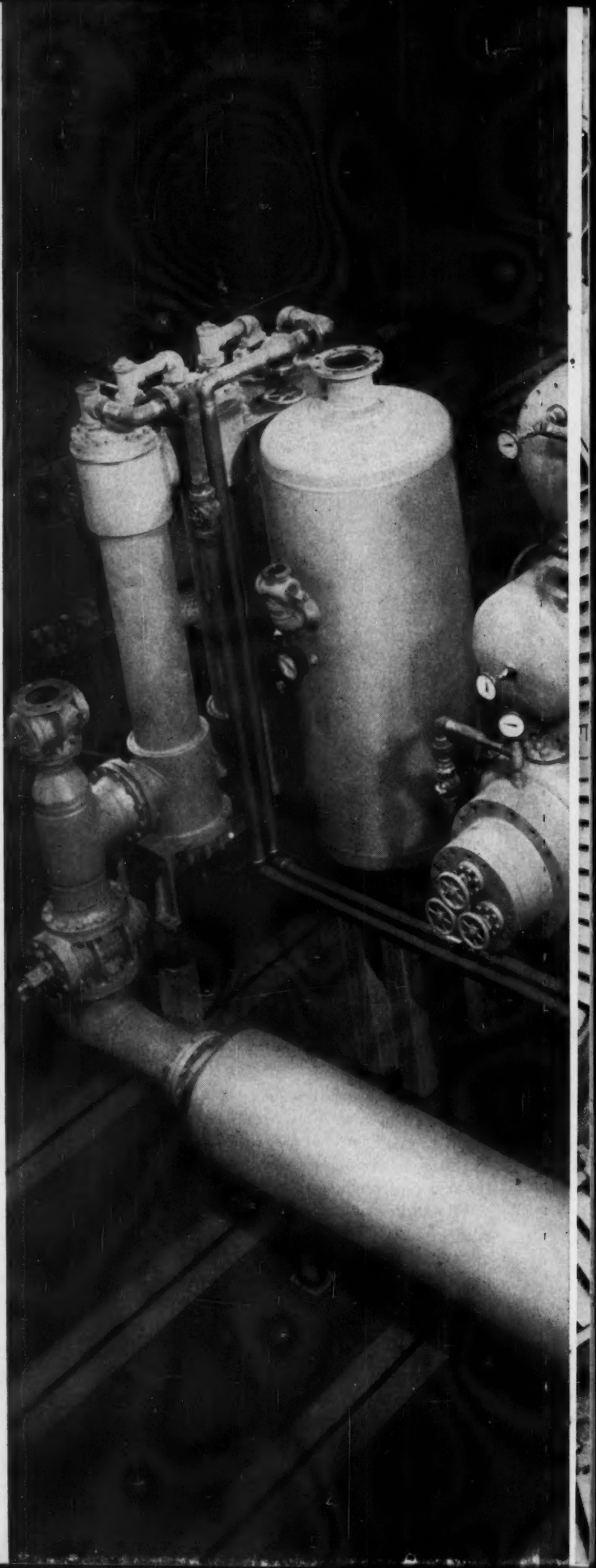
PROCESS COMPRESSOR PERFORMANCE

There's a CP Compressor exactly right for your needs, evolved from 60 years of experience in design and manufacture. Take the Class FE horizontal, balanced-opposed machine for example . . . you have a choice of many crankthrows, cylinder arrangements and staging that will give you the perfect compressor for any process requirement.

Other CP Compressors from 7½ to 5,000 hp. For vacuum service and for pressures to 15,000 psig. . . . motor or steam drive.



Class FE-44 horizontal, balanced-opposed, 4-stage compressor, in liquifaction service.



Chicago Pneumatic

8 East 44th St., New York 17, N.Y.

AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS
ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS

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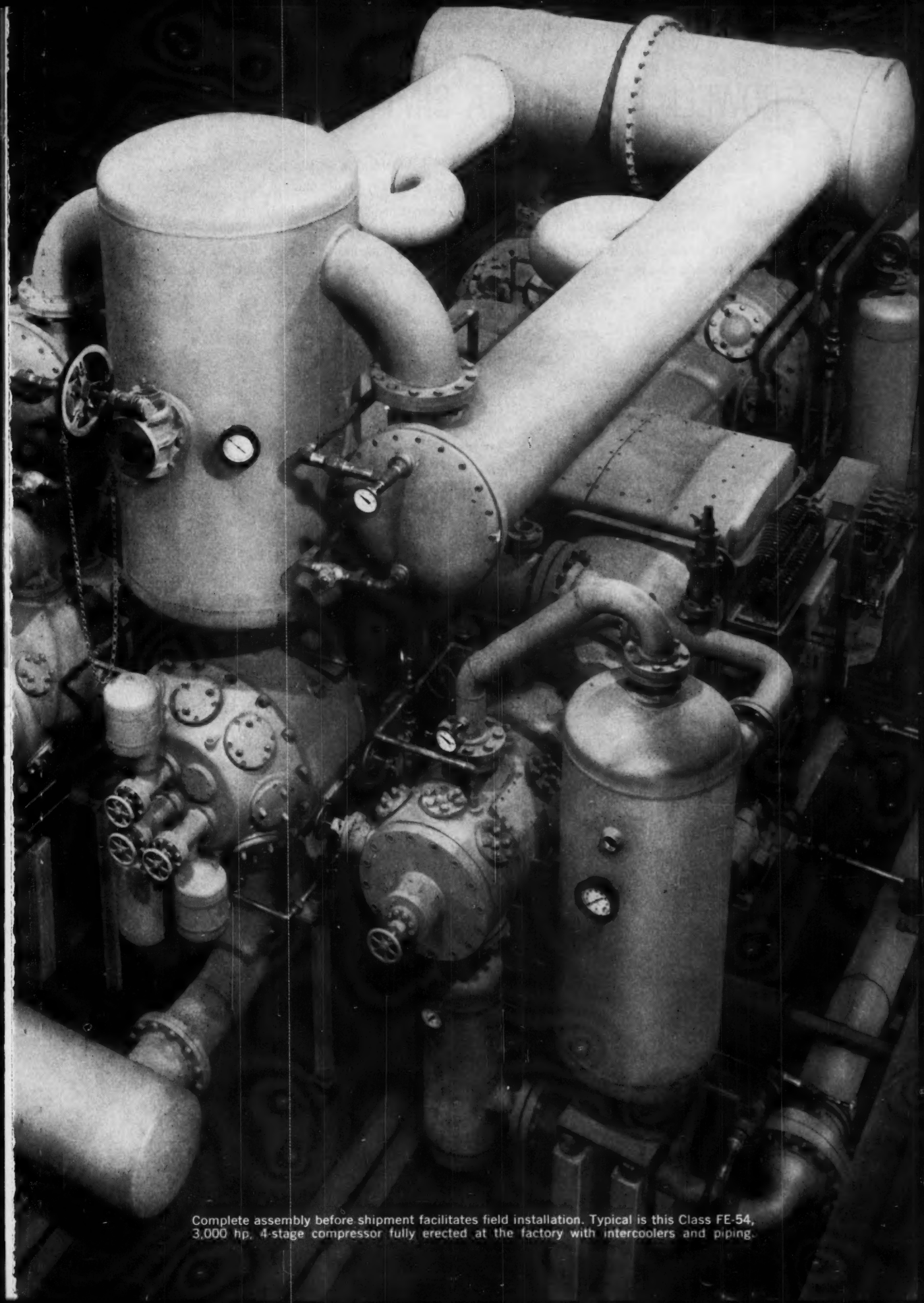


Complete assembly before shipment facilitates field installation. Typical is this Class FE-54, 3,000 hp, 4-stage compressor fully erected at the factory with intercoolers and piping.

POWELL MAKES IT A SIMPLE MATTER

To find the right valve for power plant installation, just call Powell. It's that simple, since Powell can supply just about any type of valve you may need to control water, oil, gas, air, steam or corrosive fluids.

What's more, you don't have to wonder about Powell performance. It's built-in through sound engineering, development, materials and workmanship . . . and proved day in, day out.

So, remember, finding the right valve can be a simple matter when you specify Powell. For further information, call your nearby Powell Valve Distributor (there's one in every major city), or write us direct.

115th year of manufacturing industrial valves for the free world

POWELL HIGH PRESSURE **VALVES**

THE WM. POWELL COMPANY CINCINNATI 22, OHIO

For more facts circle 248 on Reader Service card, p 109

LOUIS N ROWLEY, EDITOR • SEPTEMBER 1961 • ESTABLISHED 1882 **Power**

Resume nuclear testing?

In our considered opinion the answer to that question is an urgent "yes." We thus take our position on the side of those recommending that President Kennedy authorize early resumption of nuclear testing—testing that is vital to our long-range national interests and to the peaceful development of nuclear energy.

We do so, fully aware that *permanent* and *guaranteed* control of nuclear testing is of paramount importance to world peace. Why, then, speak out against the present moratorium on testing? Because, we are convinced, it not only brings us no closer to permanent controls but it actually presents an obstacle to ultimately achieving a system that will be truly effective. And by adhering to what may well be a unilateral moratorium, we are delaying exploration of an essentially new area in the application of nuclear explosives.

During the past several years we have striven honestly and patiently to reach agreements with the Russians that would be meaningful both in the nuclear test field and in the broader field of general disarmament. The moratorium on nuclear testing was our effort to demonstrate sincerity of purpose, to provide an atmosphere in which fruitful negotiation could take place. In view of the total lack of results, can we now consider this a valid reason?

We cannot, because the moratorium threatens our true goal, permanent and guaranteed control of nuclear testing. Such control depends on completely reliable means for detecting and identifying nuclear explosions. But we now know that in the present state of the art, *underground* explosions cannot be reliably spotted. The AEC's Project Vela, designed, among other things, to increase our knowledge of underground explosion phenomena, has advanced as far as possible through the study of conventional explosions but stands stymied by inability to investigate the characteristics of nuclear explosions. We owe it to ourselves, and to the world, to complete this project in the hope that reliable detection means may be developed.

Last, but far from least, the present moratorium on testing has also interrupted AEC's Project Plowshare, designed to investigate the potentially enormous possibilities in the peaceful use of nuclear explosives. It is obvious that devices such as the hydrogen bomb offer hitherto undreamed of energy concentrations, but it is not widely realized that large devices of this kind also represent a relatively low-cost form of energy.

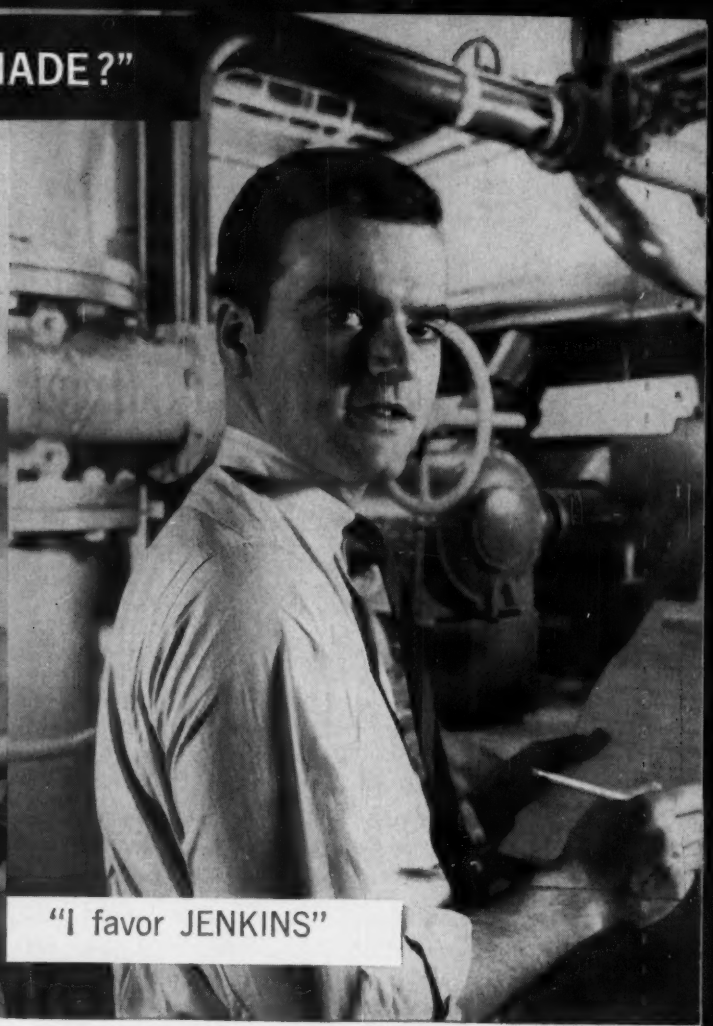
Data from past underground tests have led to theoretical studies of the use of nuclear explosives for massive excavation projects such as artificial harbors, for low-cost mining methods that might unlock vast resources of low-grade ores, for new approaches to wringing petroleum products from tar sands and oil shales, and for major modifications of underground strata to improve our water resources. It has even been proposed that we use nuclear explosives to create vast underground caverns which might serve as "retorts" for the production of basic chemicals by nuclear heat, or as "boilers" for the generation of electric power.

Here are possibilities of sobering magnitude, not only for the U.S. but, more importantly, perhaps, for the underdeveloped countries of the world. Nevertheless, they will remain just that—possibilities—until we can carry out actual tests.

When it is realized that underground testing can be controlled to virtually eliminate radioactive contamination and fallout problems, the case for early resumption of testing seems irresistible.

"WHAT'S THE BEST VALVE MADE?"

"JENKINS o'course"



"I favor JENKINS"

Whatever The Type...It's A Good Feeling

Most Trusted Trademark in the Valve World

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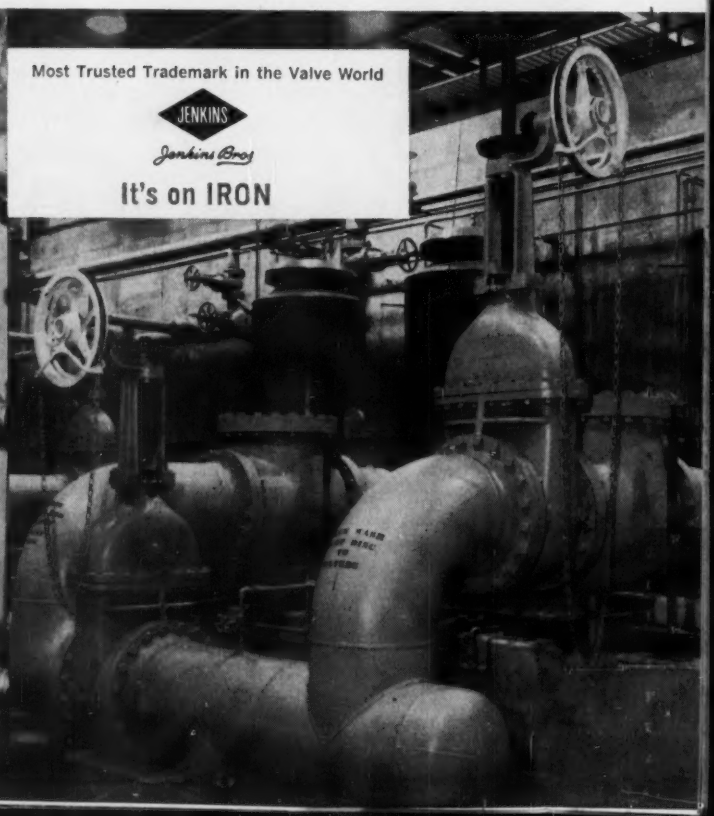
It's on BRONZE



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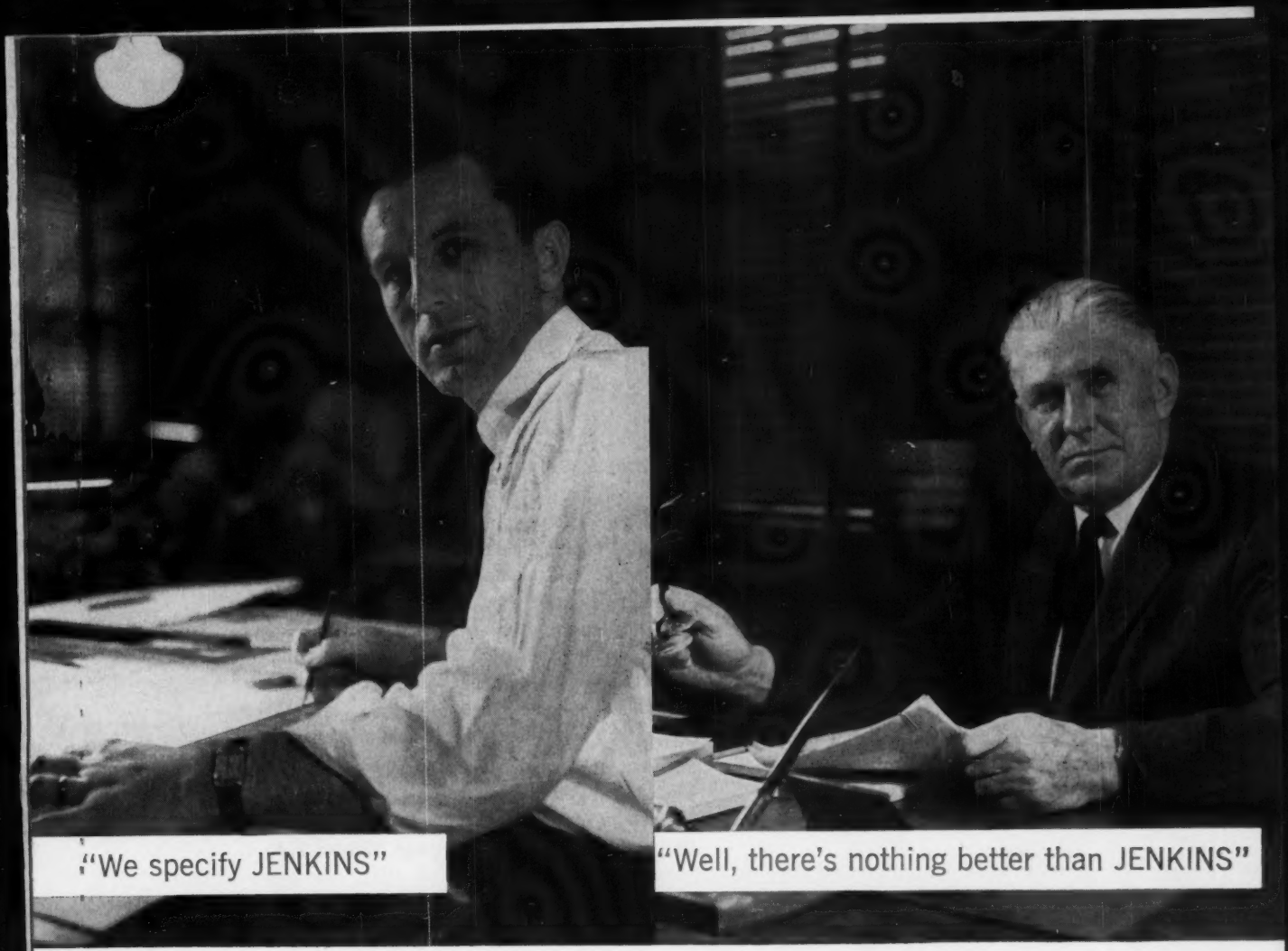
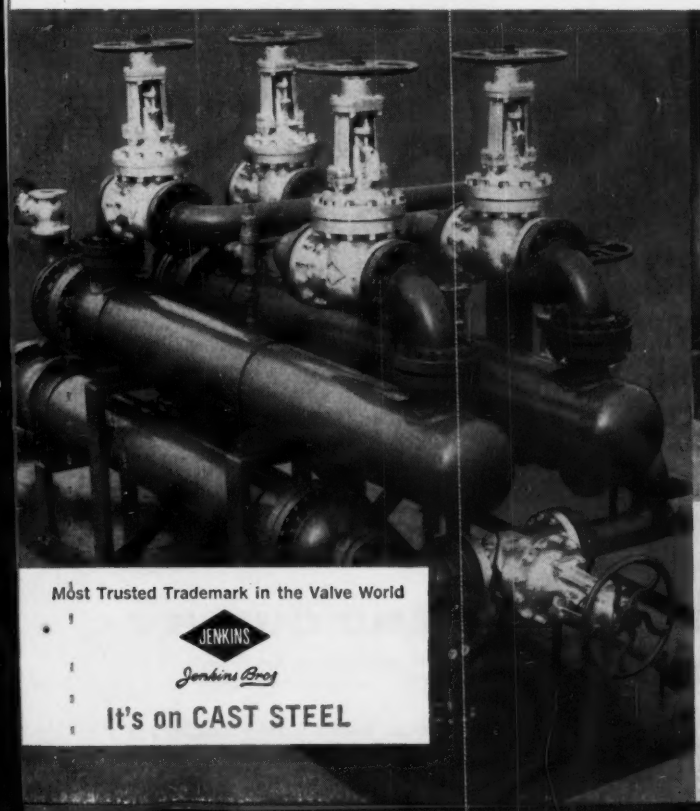
It's on IRON



To Have The Valve Everyone Trusts



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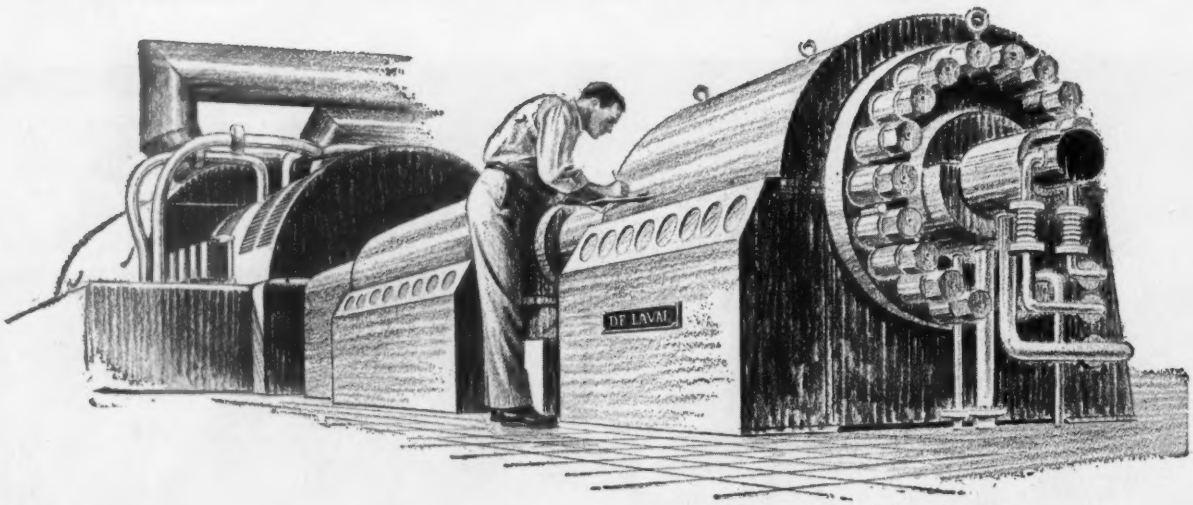
DE LAVAL engineering ingenuity means low-cost feed for giant boilers

Electricity remains "America's biggest bargain" because of the applied engineering ingenuity of the nation's electric utilities and their suppliers. Case in point: the planned installation of high-capacity De Laval boiler-feed pumps at a prominent utility. For the first time in a U. S. utility, boiler-feed pumps will be driven through the governor end of the main steam turbine-generator. Costly energy-conversion processes will be eliminated; more electricity will be available for sale. The utilities will gain another tool in their continuing effort to hold the line on cost.

Whether you have giant boilers to feed, or other problems involving rotating machinery, De Laval engineering ingenuity can help.

De Laval Steam Turbine Company, Trenton 2, N. J.



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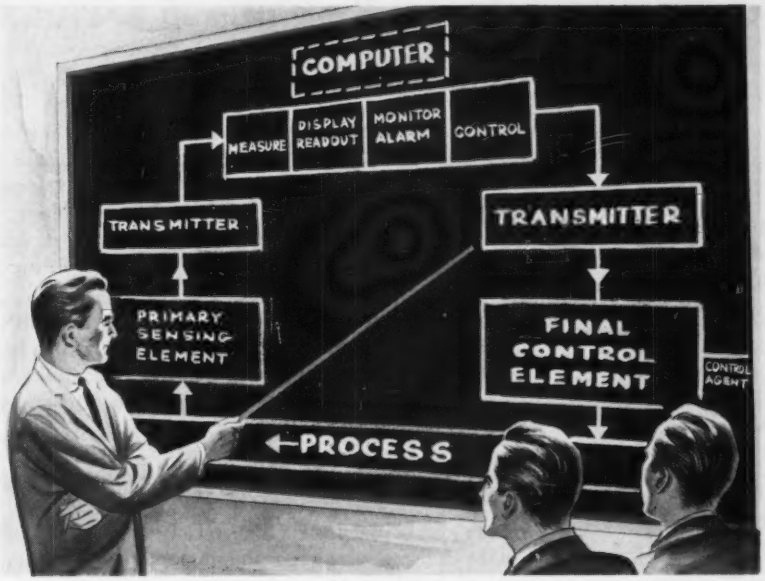
MARINE PROPULSION AND AUXILIARY EQUIPMENT • HELICAL AND EPICYCLIC GEARS • TURBOCHARGERS

◀ Circle 249 on Reader Service card for preceding ad

For more facts circle 250 on Reader Service card, p 109

Design and equipment application section

B G A SKROTZKI
Associate Editor in Charge



Power survey shows 447 educational opportunities in . . .

Instrumentation and process control

- 30 by instrument manufacturers
- Correspondence schools offer 15
- Extension courses total 61
- Trade and vocational schools have 66
- 45 available through technical institutes
- Junior colleges post 44
- Undergraduate and graduate schools list 186

By STEVE ELONKA, Associate Editor

Trained instrument men are hard to come by. Why? Simply because the manpower demand, created by industry switching from man-supervised and man-controlled operations to automatic continuous processes, has far outstripped the scant supply of qualified instrument technicians and engineers. So much so that combing the field in search of skilled instrument men is a regular, at times unrewarding, chore for energy-systems engineers.

The problem boils down to continuing the search, training your own, or doing a little of both. In the long run you will probably find it best to train

Highly practical training offered by manufacturers serves

some men now on the staff in the science of instrumentation. Hand-pick those who have shown interest and a degree of skill in dealing with instruments and control schemes. Once the potential trainees are selected, you will want to sign them up for a specialized course: days, evenings or correspondence. But when you start looking for a listing of schools that might fit the bill, you run into your first hurdle. Prior to the listing found on the following pages, no easy-to-use rundown was available.

The editors of POWER spent months compiling this listing. Finished product represents an authoritative and reasonably complete tabulation of schools, curricula, length of courses, etc. Use it as a guide in selecting schools and courses—a first step in building an instrument department.

Instrument and control manufacturers . . .

provide specialized instruction, mostly on a no-cost basis for users of their own equipment. Customer nominates students, who should possess basic instrument knowledge and experience. Main purpose of these programs: teach instrument engineers and technicians up-to-date service and maintenance procedures, prepare them to handle problems they meet on the job. Some of these training programs also include courses tailored to individual requirements. Some manufacturers are willing at times to come into the customer's plant to conduct extension courses for employees.

Most courses divide into lectures and bench work. Study material is made available and laboratory instruments and tools are loaned for each program. Student or his firm pays for transportation, room and board. Students are often housed within walking distance of the training center.

All instrumentation courses divide into six main topics

Basic math & science: some or all of the various branches of physics — electronics, pneumatics, hydraulics, mechanics, optics — and mathematics — algebra, trigonometry, elementary calculus. These are a necessary background for understanding the sophisticated equipment and systems used in the fast-growing field of instrumentation.

Process measurement covers techniques for handling the many variables such as temperature, pressure, flow, level, as well as associated display and readout techniques—indication, recording and integration.

Product measurement: instrument techniques used to identify and measure the constituents or components of a material, either directly — by spectroscopy, chromatography, nuclear magnetic resonance—or indirectly — pH, infrared methods, hydrometry, combustibles; or for measuring product's physical qualities—density, viscosity, crystal structure. Instruments and electronic test equipment are directed toward continuous or at least automated measurement while the product is manufactured or processed.

continued

FIRM AND ADDRESS	COURSES: Basic math & science	Process measurement	Product measurement	Automatic control	Data processing & computing	Control test & analysis	ENTRANCE REQUIREMENTS: High-school graduate	Employment in field	Entrance tests	Length of course
Alwac Computer Div, El-Tronics Inc 13040 S Cerise Ave Hawthorne, Calif.					•			•		5 wk
Bailey Meter Company 1036 Ivanhoe Rd Cleveland 10, Ohio		•	•	•				•		2 wk each course
Barber Colman Company 1200 Rock St Rockford, Ill.		•		•				•		1, 2 or 3 wk
Beckman Instruments, Inc, Scientific & Process Instruments Div 2500 Fullerton Rd, Fullerton, Calif.			•	•	•	•		•		10 wk
The Bristol Company Waterbury 20, Conn.				•	•			•		1 or 2 wk
Consolidated Electrodynamics Corp Pasadena, Calif.			•	•	•			•		2 days to 2 wk
Controls System Div, Daystrom, Inc 4455 Miramar Rd La Jolla, Calif.					•			•		1 to 6 wk
Electrodata Div, Burroughs Corp 460 Sierra Madre Villa Pasadena, Calif.					•			•		13 to 16 wk

to complement courses available from schools, colleges

MANUFACTURERS continued

FIRM AND ADDRESS	COURSES: Basic math & science	Process measurement	Product measurement	Automatic control	Data processing & computing	Control test & analysis	ENTRANCE REQUIREMENTS: High-school graduate	Employment in field	Entrance tests	Length of course
Fischer & Porter Company 590 Warminster Rd Warminster, Pa.		•		•				•		2 wk
Foxboro Company 38 Neponset Ave Foxboro, Mass.		•		•		•		•		1, 2 or 3 wk
General Electric Company 40 Federal St West Lynn, Mass.		•	•	•				•		1 to 2 wk
GPE Controls, Inc 240 E Ontario St Chicago 11, Ill.				•				•		2 days
Hagan Chemicals & Controls, Inc Hagan Center, Box 1346 Pittsburgh 30, Pa.		•		•	•			•		8 days
The Hays Corp 742 E 8th St Michigan City 46, Ind.		•	•	•				•		1 wk each course
Industrial Nucleonics Corp 650 Ackerman Rd Columbus, Ohio		•		•				•		4 to 5 days
Leeds & Northrup Co 4901 Stenton Ave Philadelphia 44, Pa.		•	•	•						1 wk each course
Librascope Incorporated 810 Western Ave Glendale 1, Calif.			•		•			•		3 days
Mason-Neilan Div Worthington Corporation 33 Nahatan St, Norwood, Mass.		•		•				•		4 to 5 days
Minneapolis-Honeywell Regulator Co Education Ctr, Wayne & Windrim Ave Philadelphia 44, Pa.		•	•	•	•	•		•		1 to 6 wk
Moore Products Company H & Lycoming St Philadelphia 24, Pa.		•		•				•		4 mo – 1 session per wk
Radio Corp of America 21 Strathmore Rd Natick, Mass.				•	•			•		1 to 3 wk, 3 months
Reliance Electric & Engineering Co 24701 Euclid St Cleveland 17, Ohio				•				•		5 days
Republic Flow Meters Company 2240 Diversey Pkwy Chicago 47, Ill.		•		•				•		3 wk
Sanborn Company 175 Wyman St Waltham 54, Mass.			•					•		1 wk
Swartwout Div, Crane Co Hooksett Industrial Pk Manchester, N. H.		•		•				•		1 wk
Taylor Instrument Co 95 Ames St Rochester 1, N. Y.		•		•		•		•		2 wk
TRW Computers Co 202 N Canon Dr Beverly Hills, Calif.					•			•		2, 3 or 4 wk
Wallace & Tiernan, Inc. 25 Main St Belleville 9, N. J.		•		•				•		12 wk – 1 session per wk
Canada Ferranti-Packard Electric Ltd Toronto 15, Ont.					•					8 evening lectures (2 hr ea)
Fischer & Porter, Ltd Downsville, Ont.		•		•				•		2 wk

Automatic control: transmitting electric and pneumatic signals, scanning and alarm systems, standard industrial pneumatic, hydraulic and closed-loop automatic control equipment, including such special techniques as program and combustion control. Theory includes descriptive (nonmathematical) treatment of on-off, proportioning, automatic reset and rate-action control.

Data processing & computing studies begin with techniques for digitizing measured signals and putting this information into usable form through data-reduction equipment. Digital computers are studied as they perform mathematical functions in the data-reduction system, and on-line as ultimate automatic controllers in closed-loop systems. Function and use of analog computers in on-line control is part of the picture, and, to some extent, their use in control-system test and analysis.

Control test & analysis goes into use of advanced automatic control and servomechanisms theory in the analysis and synthesis of instrumentation and control systems. Included are the special techniques of frequency-response analysis and associated electronic and electromechanical equipment and procedures.

Correspondence schools . . .

offer home-study courses, usually starting on the high-school vocational level. Some of the courses are based on outlines prepared by an Education Committee Task Force of the Instrument Society of America. They enable practical instrument technicians and others to round out their on-the-job training with related math, physics, chemistry and theory. In many cases, courses are so complete that an ambitious technician can prepare in his spare time for further education on a college level. Some colleges also offer home-study courses in instrumentation.

Correspondence instructions come in the form of printed or multigraphed lessons or assignments based on textbooks and similar material. They have directions for study, quizzes and exercises that the student can work on at home. Some schools provide a kit of films and other visual aids, instruments and lab equipment so the student can learn his subject first-hand.

Many schools work on a pay-as-you-learn basis. They reason that the student may be compelled to discontinue training after he has enrolled—therefore they collect only lesson by lesson.

SCHOOL AND ADDRESS	COURSES						ENTRANCE REQUIREMENTS			Length of course
	Basic math & science	Process measurement	Product measurement	Automatic control	Data processing & computing	Control test & analysis	High-school graduate	Employment in field	Entrance tests	
American School Chicago, Ill.	•	•		•					•	800 study hr
Capitol Radio Engineering Inst Washington, D. C.	•			•		•	•	•		1 to 4 yr
Central Technical Institute, Kansas City 8, Mo.	•						•			
Cleveland Inst of Electronics Cleveland 14, Ohio	•						•			66 lessons
DeVry Technical Institute Chicago, Ill.	•	•		•	•	•	•			100 or 160 lessons
Ebex Technical Institute, Inc Kansas City 10, Mo.	•	•		•	•	•			•	
Electronics Institute, Inc Kansas City 10, Mo.	•	•		•		•	2 yr HS			
Electronic Technical Institute Chicago 25, Ill.	•	•		•					•	50 lessons
Industrial Training Institute Chicago 25, Ill.	•	•		•		•			•	2 yr
International Correspondence Schools, Scranton 15, Pa.	•	•		•	•				•	550 study hr
Pennsylvania State University University Park, Pa.	•						•			23 6-hr lessons per course
RCA Institutes, Inc New York 14, N. Y.	•	•		•	•	•			•	550 study hr
University of Tennessee Knoxville, Tenn.	•					•			•	8 wk to 1 yr per course
United Electronics Labs Louisville 6, Ky.	•	•	•	•	•	•	•			1 ½ yr
University of Wisconsin Madison 6, Wis.	•					•	•			18-mo limit

Extension courses

SCHOOL AND ADDRESS	COURSES: Basic math & science	Product measurement	Process measurement	Automatic control	Data processing & computing	Control test & analysis	ENTRANCE REQUIREMENTS: High-school graduate	Employment in field	Entrance tests	Length of course
Alabama										
Tenn. Valley Voc-Tech School, Decatur	•	•	•	•	•	•	•			2 yr
Arizona										
Phoenix Union HS, Phoenix	•							•		
Tuscon Senior HS, Tuscon	•							•		
Colorado										
Griffith Opportunity School, Denver	•								•	
Connecticut										
Windham Reg Tech School, Willimantic	•							•		120 hr
Delaware										
H F Brown Tech HS, Wilmington	•	•	•	•		•	•	•		3 yr
District of Columbia										
Capitol Radio Engrg Inst, Washington 10	•	•				•	•	•		3 yr
Georgia										
Smith-Hughes Voc School, Atlanta	•	•					•			2 yr
Indiana										
St. Joseph Cty, S Bend Schools, S Bend	•	•							•	
Iowa										
Davenport Community School Dist, Davenport	•	•						•		
Des Moines Independent School Dist, Des Moines	•	•						•		16 hr
Kentucky										
United Electronic Labs, Louisville 16	•			•			•			78 wk
Louisiana										
Baton Rouge Voc-Tech School, Baton Rouge	•	•		•				•		100 hr
Minnesota										
Area Voc-Tech School, St. Paul	•								•	
Montana										
Montana State College, Bozeman	•				•		•			EE prg
Nebraska										
Omaha Public Schools, Omaha 31		•						•		
New Jersey										
Middlesex Cty Voc-Tech Schools, N Brunswick	•	•						•		4 yr
New York										
Central Tech HS, Syracuse	•						•			8 mo
Erie County Tech Inst, Buffalo	•	•		•		•	•			24 wk
N. Y. State A&T Inst, Alfred	•	•		•		•	•			
N. Y. State A&T Inst, Canton	•			•						
Trott Voc HS, Niagara Falls	•	•						•		9 mo
North Carolina										
Central Industrial Ed Ctr, Charlotte	•						•			18 mo
Industrial Education Centers										
1—Asheville	•						•			18 mo
2—Burlington	•						•			21 mo
3—Charlotte	•						•			18 mo
4—Wilmington	•						•			18 mo
5—Wilson	•						•			18 mo
6—Winston-Salem	•						•			18 mo
Oklahoma										
Northeastern Oklahoma A&M, Miami	•							•		
Okla. State U, Technical Inst, Stillwater	•						•			
Oklahoma U, Norman	•	•	•	•		•	•			12 hr
Pennsylvania										
Bucks County Tech School, Fairless Hills	•	•	•	•	•				•	1080 hr
Butler Area Joint Schools, Butler	•								•	
Chester Voc HS, Chester	•	•		•		•		•		360 hr
Clairton Sr HS, Clairton	•			•					•	2 yr
Connelly Voc HS, Pittsburgh	•	•	•	•	•	•	•			5 yr
M Dobbins Voc-Tech School, Philadelphia 32	•	•		•	•	•	•			
Penn. State U, Ogontz Campus, Abington	•	•					•			4 sem
Philadelphia Public Schools, Phila.	•	•						•		2 yr
Pittsburgh Public Schools, Pittsburgh	•							•		
Spring Garden Inst, Philadelphia 23	•	•		•		•	•			2 yr
Williamsport Tech Inst, Williamsport	•						•			2 yr
Texas										
Amarillo College, Amarillo	•			•				•		200 hr
Del Mar College, Corpus Christi	•	•		•						
Fort Worth Tech Inst, Fort Worth	•	•		•			•			
Lamar Tech College, Beaumont	•							•		
Lee Jr College, Baytown	•	•		•						
Frank Phillips College, Borger	•	•		•			•			72 wk
South Plains College, Levelland	•	•		•		•	•			108 hr
Texas U, Austin 12	•	•		•		•		•		200 hr
Texas U, Odessa	•	•		•						
Utah										
Central Utah Voc School, Provo		•						•		200 hr
Washington										
Lower Columbia Jr College, Longview	•						•			
Skagit Valley College, Mt. Vernon	•	•	•	•				•		12 wk
Tacoma Public Schools, Tacoma 5	•	•	•	•		•	•			3 mo
Tacoma Voc-Tech School, Tacoma	•	•		•		•			•	2580 hr
West Virginia										
West Virginia Inst of Tech, Montgomery	•			•		•	•			2 days
Wisconsin										
Milwaukee School of Engrg, Milwaukee 3	•		•		•	•	•			EE prg
Milwaukee Voc & Adult School, Milwaukee	•	•						•		72 hr
Wisconsin U, Kenosha	•	•	•	•	•		•			

Extension courses include formal classes, lectures, demonstrations given in various communities at night or on Saturdays. A college may give courses on or off the campus or by mail.

College extension courses were developed by institutions of higher learning, in widening geographical areas, to supply educational services for those who can't carry the usual full-time resident program. Courses completed at the school's extension center may add the same credit to a student's record as courses taken at the college, and count toward a degree if the student transfers to full-time college or another school. Sometimes, though, these courses are limited in amount and type of credit applicable toward a degree.

On the trade level, extension instructions are designed to supplement or extend the trade knowledge or skill of employed workers. Some schools offer preparatory and extension courses in instrumentation under Title VIII of the National Defense Education Act of 1958. Courses may be for upgrading maintenance mechanics, equipment servicemen and others who presently work in the field of instrumentation and process control.

Trade and vocational high schools

These schools offer programs below college level — working knowledge for prospective and actual instrument mechanics and technicians in manufacturing, industry and trade. The learner is usually prepared for entrance into a particular chosen vocation, or for upgrading to a better job if he's employed and attending evening classes. Some trade and vocational schools will create courses to fill exact needs of local firms—paper, steel, chemical, petrochemical industries and so on.

Entrance age is usually 16. Short courses for industrial instrument mechanics are offered by many schools, while others have complete 2- to 4-year programs including related physics. In some arrangements, students may leave school before they finish a complete program of two years or longer—if the training they complete is adequate for employment. They can continue their studies in evening school.

Schools often have very complete instrumentation labs, sometimes on a par with technical institutes and colleges. Instrument manufacturers have been most generous in supplying equipment—complete console instrumentation units in several cases — so the schools can turn out trained personnel to benefit industry.

SCHOOL AND ADDRESS	COURSES: Basic math & science	Process measurement	Product measurement	Automatic control	Data processing & computing	Control test & analysis	ENTRANCE REQUIREMENTS: High-school graduate	Employment in field	Entrance tests	Length of course
California										
Solar Electronics School, Monrovia	•				•		•			882 hr
Connecticut										
H H Ellis Voc-Tech School, Danielson	•								•	
W F Kaynor Tech School, Waterbury	•								•	2800 hr
Delaware										
H Fletcher Brown Voc HS, Wilmington	•	•		•		•		•		400 hr
District of Columbia										
A G Bell Voc HS, Washington 10	•						•			3 yr
Florida										
Lindsey-Hopkins Tech HS, Miami	•	•		•			•			70 cr
Georgia										
Augusta Voc School, Augusta	•						•		•	2 yr
Idaho										
School of Trade & Tech Ed, Pacatello	•	•					•			3 yr
Illinois										
Chicago Voc HS, Chicago	•	•		•			•	•		4 yr
Community Unit HS, Granite City	•							•		
Coyne Electrical School, Chicago	•	•		•					•	60 wk
E Alton-Wood River HS, Wood River	•	•		•			•			2 ¼ yr
Indiana										
Arsenal Tech HS, Indianapolis	•								•	60 hr
Kentucky										
Ashland Voc School, Ashland	•	•		•				•		40 hr
Louisville Radio School, Louisville	•	•				•			•	2700 hr
Somerset Voc School, Somerset	•								•	22 mo
Louisiana										
T.H Harris Trade School, Opelousas	•	•		•	•		•			2640 hr
Jefferson Parish Trade School, Gretna	•	•			•		•	•		144 hr
Maine										
Maine Voc Tech Inst, South Portland	•						•		•	140 wk
Massachusetts										
Industrial Tech Inst, Boston	•						•			68 wk
Lynn Trade HS, Lynn	•								•	3 yr
Medford Voc School, Medford	•						•	•		450 hr
Saunders R & E School, Boston	•						•			1920 hr
Worcester Ind-Tech Inst, Worcester	•						•			10 wk
Michigan										
Electronics Inst, Detroit	•	•		•			•			30 mo
Wilbur Wright Voc HS, Detroit	•								•	4 yr
Minnesota										
Mankato Voc-Tech School, Mankato	•								•	216 wk
St. Paul Area Tech-Voc School, St. Paul 1	•	•						•		2 sem
St. Paul Boys Voc School, St. Paul	•						•			3 yr
Thief River Falls Lincoln HS, Thief River Falls	•						•			18 mo
Missouri										
D Ranken Jr Mech Trade School, St. Louis 13	•	•		•			•			2 yr
Nebraska										
Omaha Public Schools, Omaha 31	•	•		•			•			2 yr
New Jersey										
Camden Cty Voc School, Merchantville	•						•			4 yr
Middlesex Cty Voc-Tech HS, N Brunswick	•	•	•	•				•		5 yr
New York										
Industrial HS, Troy	•	•		•			•			9 cr
Kingston HS, Kingston	•								•	
Queens Voc HS, Long Island City 1	•			•					•	3 yr
Syracuse Central Tech HS, Syracuse 3	•	•		•					•	33 hr
North Carolina										
Industrial Education Ctr, Wilmington	•	•		•				•		40 hr
Ohio										
Central HS, Cincinnati 23	•						•			
Oregon										
Eugene Tech-Voc School, Eugene	•						•			44 units
Pennsylvania										
Connelley Tech Evng School, Pittsburgh	•	•		•			•	•		5 yr
Connelley Voc HS, Pittsburgh	•	•		•				•		180 hr
Penn. Tech Inst, Pittsburgh	•									21 mo
Spring Garden Inst, Philadelphia	•	•		•			•	•		4 terms
Williamsport Tech Inst, Williamsport	•								•	2 yr
South Carolina										
S. C. Area Trade School, W Columbia	•	•		•	•	•	•			
Tennessee										
Fulton Voc Electronic School, Knoxville 17	•						•		•	24 mo
Texas										
Amarillo College, Amarillo	•	•		•				•		54 hr
Pasadena Sr HS, Pasadena	•	•		•		•		•		10 wk
Voc & Tech School, Houston	•	•		•					•	
Utah										
Central Utah Voc School, Provo	•	•		•		•		•		200 hr
Salt Lake Trade Tech Inst, Salt Lake City 2	•							•		2064 hr
Vermont										
Burlington HS, Burlington	•								•	
Rutland HS, Rutland								•		
Springfield HS, Springfield	•								•	
St. Johnsbury Trade School, St. Johnsbury	•								•	4 yr
Virginia										
Danville Tech Inst, Danville	•								•	
Washington										
Spokane Tech-Voc School, Spokane	•				•		•			18 mo
Tacoma Voc-Tech Inst, Tacoma 5	•	•		•				•		2580 hr
West Virginia										
Raleigh County Voc School, Beckley	•						•		•	3 yr
Wisconsin										
Appleton Voc School, Appleton	•	•		•					•	20 wk
Kenosha Voc School, Kenosha	•							•		48 hr
Madison Inst of Tech, Madison 3	•						•			2 yr
Menasha Voc School, Menasha	•	•		•				•		40 hr
Oshkosh Inst of Tech, Oshkosh	•						•			2 yr

Technical institutes

SCHOOL AND ADDRESS	COURSES: Basic math & science	Process measurement	Product measurement	Automatic control	Data processing & computing	Control test & analysis	ENTRANCE REQUIREMENTS: High-school graduate	Employed in field	Entrance tests	Length of course or degree
Alabama										
Athens Coll & Voc-Tech Sch, Athens	•	•					•			11 qtr
California										
Cogswell Poly College, San Francisco	•	•		•		•	•		•	4 sem
Grantham Sch of Electrn, Hollywood 7	•						•			
RCA Inst, Los Angeles 14	•	•		•	•	•	•			2650 hr
West Coast U, Los Angeles	•				•	•		•		
Connecticut										
Bridgeport Engrg Inst, Bridgeport	•		•	•		•	•		•	45 hr
Norwalk State Tech Inst, Norwalk	•	•	•	•	•	•	•			2 yr
State Tech Inst, Hartford	•			•			•			4 cr
Ward School of Electronics, Hartford	•	•		•		•	•			2 yr
Georgia										
Southern Tech Inst, Chamblee	•						•			7 cr
Idaho										
Trade & Tech Ed School, Pacatello	•	•		•		•	•			
Illinois										
DeVry Tech Inst, Chicago	•	•		•		•	•			36 wk
Massachusetts										
Franklin Tech Inst, Boston	•	•		•			•			2 cr
Industrial Tech Sch, Boston	•	•		•			•		•	4 mo
Saunders Radio & Electron Sch, Boston	•	•		•			•		•	1920 hr
Wentworth Inst, Boston	•						•			144 hr
Michigan										
Lawrence Tech Inst, Detroit	•						•			3 cr
Missouri										
Central Tech Inst, Kansas City	•			•		•	•			
New York										
Hudson Valley Tech Inst, Troy	•						•			8 cr
Long Island A & T Inst, Farmingdale	•						•			2 yr
Mohawk Valley Tech Inst, Utica	•			•			•			4 yr
New York Inst of Tech, New York 23	•	•		•		•	•		•	12 sem
N.Y.S. Agr & Tech Inst, Morrisville	•	•		•			•			2 yr
RCA Inst, New York 14	•	•		•	•	•	•			2650 hr
Rochester Inst of Tech, Rochester	•						•			2 yr
State U of N. Y., Farmingdale	•	•		•			•			2 yr
Ohio										
Dayton U Tech Inst, Dayton	•						•			4 cr
Fenn Coll Tech Inst, Cleveland	•	•		•			•			16 wk
Ohio Mechanics Inst, Cincinnati	•						•			3 yr
Oregon										
Multnomah College, Portland	•	•		•			•			3 sem
Oregon Tech Inst, Klamoth Falls	•	•		•			•			3 cr
Pennsylvania										
Penn. State U Tech Inst (12 locations)	•	•	•	•	•	•	•			11 cr
Philadelphia Wireless Tech Inst, Phila.	•			•			•			2 yr
Temple U Tech Inst, Philadelphia	•			•	•	•	•			6 sem
Williamsport Tech Inst, Williamsport	•	•		•			•			2 yr
Texas										
Del Mar Tech Inst, Corpus Christi	•	•		•		•	•			300 hr
Lamar Voc School, Beaumont	•			•			•			2 sem
Vermont										
Vt. Agr & Tech Inst, Randolph Center	•	•					•			2 yr
Virginia										
William & Mary Coll Tech Inst, Norfolk	•	•		•			•			2 yr
Washington										
Edison Tech School, Seattle	•						•			
J M Perry Inst, Yakima	•	•		•			•			2 yr
Tacoma Voc-Tech Inst, Tacoma	•	•		•			•			2 yr
West Virginia										
West Va. Inst of Tech, Montgomery	•	•		•			•			2 sem
Wisconsin										
Milwaukee Inst of Tech, Milwaukee	•	•		•			•		•	1 yr
Milwaukee School of Engrg, Milwaukee	•				•		•			

Junior colleges

Arkansas										
Little Rock Jr Coll, Little Rock	•			•			•			2 yr, AA
California										
Antelope Valley Coll, E Lancaster	•					•	•			2 yr, AA
Bakersfield Coll, Bakersfield	•					•	•			2 yr, AA
Cerritos Coll, Norwalk	•						•			2 yr, AA
E Contra Jr Coll, Concord	•						•			
El Camino Coll, Los Angeles Cty	•	•					•			AA
Long Beach City Coll, Long Beach 13	•			•			•			16 cr
Los Angeles Harbor Coll, Wilmington	•	•	•	•			•			AA
Monterey Peninsula Coll, Monterey	•						•			
Mt San Antonio Coll, Walnut	•	•		•				•		54 hr
Pasadena City Coll, Pasadena	•	•		•			•			2 yr, AA
S. Bernardino Val Coll, S. Bernardino	•						•			
San Diego Jr Coll, San Diego 2	•					•	•			AA
Santa Monica City Coll, Santa Monica	•			•		•	•			AA
Colorado										
Pueblo Jr Coll, Pueblo	•					•	•			

continued

Separate organizations or divisions of a college, technical institutes offer instruction which may lead to the degree of Associate in Applied Science. Courses are geared to students who have completed high school or who are able to succeed in post-high-school courses — indicated by satisfactory marks on the General Educational Development (GED) Test. One year of high-school algebra and one year of plane geometry are often prerequisites.

The TI graduate is on a semiprofessional level, between a skilled craftsman and a professional engineer. Many find employment with leading instrumentation firms, others in oil, chemicals, aeronautics, utilities. The TI graduate is the right hand of the professional instrument engineer, competent to install and troubleshoot highly technical equipment.

The junior college is a post-high-school institution offering a 2- (occasionally 3-) year program, either complete in itself or as preparation for further training. Students usually earn an Associate in Arts—AA—degree.

Junior colleges that don't offer an AA degree may have a short course in instrumentation to suit a given local industry. In such cases, credits can sometimes be used for future degree work in accredited colleges.

JUNIOR COLLEGES

SCHOOL AND ADDRESS	COURSES						ENTRANCE REQUIREMENTS			Degree
	Basic math & science	Process measurement	Product measurement	Automatic control	Data processing & computing	Control test & analysis	High-school graduate	Employed in field	Entrance tests	
Florida										
Pensacola Jr Coll, Pensacola	•	•		•			•			AA
St. Petersburg Jr Coll, St. Petersburg 10	•	•				•	•			AA
Georgia										
Armstrong Coll of Savannah, Savannah	•	•					•			AA
Illinois										
Chicago City Jr Coll, Chicago 34	•						•			
Maryland										
Catonsville Comm Coll, Catonsville 28	•						•			AA
Harford Jr Coll, Del Air	•						•			AA
Michigan										
Alpena Comm Coll, Alpena	•						•			
Flint Comm Jr Coll, Flint 3	•						•			
Henry Ford Comm Coll, Dearborn	•	•		•		•	•			
Mississippi										
Perkinston Jr Coll, Perkinston	•						•			AA
New Jersey										
Trenton Jr Coll, Trenton 8	•	•					•			AA
New York										
Bronx Comm Coll, Bronx 68	•			•			•			AA
Bronx Tech Comm Coll, Binghamton	•						•			AA
Dutchess Comm Coll, Poughkeepsie	•		•				•			AA
Orange Cty Comm Coll, Middletown	•						•			AA
Staten Island Comm Coll, Staten Island	•						•			AA
North Carolina										
Charlotte Coll, Charlotte 4	•								•	AA
North Dakota										
N. D. State Sci of Science, Wahpeton	•						•			
Oregon										
Central Oregon Coll, Bend	•						•			AA
Pennsylvania										
Penn. State U, Hazleton	•						•			AA
Texas										
Amarillo Coll, Amarillo	•			•			•			
Del Mar Coll, Corpus Christi	•	•		•			•			AA
Houston U Jr Coll, Houston	•						•			AA
Lee Coll, Baytown	•	•		•			•			33 cr
The Victoria Coll, Victoria	•	•					•			AA
Utah										
Dixie Jr Coll, St. George	•						•			AA
Washington										
Everett Jr Coll, Everett	•	•		•			•			10 wk, 3cr
Lower Columbia Jr Coll, Longview	•	•		•		•	•			AA
Wyoming										
Casper Coll, Casper	•						•			

The international scene

To round out our survey, here are some foreign colleges and universities that offer courses in instrumentation and process control:

Australia: Melbourne U; New South Wales U; Queensland U; Sydney U
Belgium: L'Institut Belge de Regulation et d'Automatisme, Brussels
British Isles: Birmingham U; Bristol U; Cambridge U; London U; Wales U, Swansea
Canada: Alberta U, Edmonton; British Columbia U, Vancouver, B.C.; Carleton U, Ottawa, Ont.; McGill U, Montreal, P.Q.; Queens U, Kingston, Ont.; Royal Military College, Kingston, Ont.
Czechoslovakia: Technical U, Prague **Denmark:** Technical U, Copenhagen
France: Ecole Nationale Superieure d'Aeronautique, Paris; Ecole Polytechnique, Paris; Ecole Superieure d'Electricite, Paris; Grenoble U; Institut des Arts et Metiers, Paris; Paris U
Germany: Darmstadt Technische Hochschule; Stuttgart U
Hungary: Technical U, Budapest
India: Institute of Technology, Bangalore **Israel:** Technion, Tel Aviv
Italy: Bologna U
Japan: Electrical Engineering College, Tokyo; Kyoto U; Kyushu U; Tokyo Institute of Technology, Tokyo; Tokyo U, Bunkyo-ku; Waseda U, Tokyo
Netherlands: Phillips Institute of Technology, Eindhoven
Norway: Technical U, Bergen **Poland:** Technical Institute, Warsaw
Rumania: Technical U, Bucharest
Sweden: Chalmers Institute of Technology, Gothenburg; Technical U, Stockholm
Switzerland: Lausanne U; Zurich Technische Hochschule
Turkey: Technical U, Istanbul

Undergraduate and graduate schools

SCHOOL AND ADDRESS	COURSES: Basic math & science	Process measurement	Product measurement	Automatic control	Data processing & computing	Control test & analysis	ENTRANCE REQUIREMENTS: High-school graduate	Employment in field	Entrance tests	Courses are part of formal engineering curriculum on levels indicated: Bachelor	Master	Doctor
Alabama												
Alabama Polytechnic Inst, Auburn	•	•		•	•	•	•			•		
Alabama U, University, Ala.	•	•	•	•	•	•	•			•	•	
Alaska												
Alaska U. College, Alaska	•				•	•	•			•		
Arizona												
Arizona U, Tuscon	•	•		•	•	•	•			•	•	•
Arkansas												
Arkansas U, Fayetteville	•	•		•	•	•	sr/grad			•	•	•
California												
California Inst of Tech, Pasadena 4	•				•	•	•			•	•	•
California State Poly, San Luis Obispo	•	•		•	•	•	•			•	•	
California U, Berkeley 4	•			•	•	•	•			•	•	•
California U, Los Angeles	•			•	•	•	•			•	•	•
City College, San Francisco 12	•			•			•			•		
Cogswell Poly College, San Francisco 10	•	•		•			•			•		
Heald Engrg College, San Francisco	•				•	•	•			•		
Loyola U of L.A., Los Angeles 45	•			•	•	•	•			•		
Stanford U, Palo Alto	•	•		•	•	•	•			•	•	•
U.S. Naval Post Grad School, Monterey	•	•		•	•	•	•			•	•	•
West Coast U, Los Angeles	•	•		•	•	•	•			•		
Colorado												
Colorado State U, Fort Collins	•			•		•	•			•		
Denver U, Denver	•				•	•				•		
Ft Lewis A & M College, Durango	•				•		•			•		
U. S. Air Force Academy, Colorado Springs	•				•	•	•			•		
Connecticut												
Bridgeport Engrg Inst, Bridgeport 3	•	•		•			BS					
Bridgeport U, Bridgeport	•				•	•	•			•		
Connecticut U, Storrs	•	•		•	•	•	•			•	•	•
Yale U, New Haven	•	•	•	•	•	•	•			•	•	•
District of Columbia												
Catholic U of America, Washington 17				•			BS		•	•		
George Washington U, Washington 6	•			•	•		•			•	•	D Sc
Florida												
Florida U, Gainesville	•			•	•	•	•			•	•	•
Miami U, Coral Gables	•			•		•	•			•		
Georgia												
Georgia Inst of Tech, Atlanta	•			•	•	•	•			•		
Idaho												
Idaho U, Moscow	•			•	•	•	•			•		
Illinois												
Bradley U, Peoria 5	•			•	•	•	•			•	•	
Illinois Inst of Tech, Chicago 16	•			•	•	•	•			•	•	•
Illinois U, Urbana	•			•	•	•	•			•	•	•
Northwestern U, Evanston	•			•	•	•	•			•	•	•
Indiana												
Notre Dame U, South Bend	•			•	•	•	•			•	•	•
Purdue U, Lafayette	•			•	•	•	•			•	•	•*
Valparaiso Tech Inst, Valparaiso	•			•	•	•	•			•		
Valparaiso U, Valparaiso	•			•	•	•	•			•		
Iowa												
Iowa State U, Ames	•			•	•	•	•			•	•	•
Kansas												
Kansas State U, Manhattan	•			•	•	•	•			•	•	•
Kansas U, Lawrence	•			•	•	•	•			•	•	•
Wichita U, Wichita	•			•	•	•	•			•	•	
Kentucky												
Kentucky U, Lexington	•				•					•		
Louisville U, Louisville	•	•			•		•			•	•	•
Louisiana												
Louisiana Poly Inst, Ruston	•			•	•	•	•			•	•	
Louisiana State U, Baton Rouge	•				•	•	•			•		
Southern U & A & M College, Baton Rouge	•			•	•	•	•			•		
Tulane U of La., New Orleans 18	•					•	•			•		
Maine												
Maine U, Orono	•	•	•	•		•	•			•		
Maine U, Portland	•			•	•	•	•			•		
Maryland												
Marvland U, College Park	•			•	•	•	•			•	•	•
Massachusetts												
Harvard U, Cambridge	•				•	•	•			•	•	•*
Massachusetts Inst of Tech, Cambridge	•	•	•	•	•	•	•			•	•	•*
Massachusetts U, Amherst	•			•		•	•			•		
Northeastern U, Boston 15	•			•	•	•	•			•		
Worcester Poly Inst, Worcester 9	•			•	•	•	•			•		
Michigan												
Detroit Inst of Tech, Detroit 26	•					•	•			•		
Detroit U, Detroit 21	•	•					•			•		
Michigan College of M & T, Houghton	•			•	•	•	•			•		
Michigan State U, East Lansing	•			•	•	•	•			•	•	•
Michigan U, Ann Arbor	•	•	•	•	•	•	•			•	•	•*
Minnesota												
Minnesota U, Minneapolis	•			•	•	•	•			•	•	•
Mississippi												
Mississippi State U, State College, Miss.	•			•	•	•	•			•		
Mississippi U, University, Miss.	•			•	•	•	•			•		
Missouri												
Missouri School of M & T, Rolla	•						•			•		
Missouri U, Columbia	•			•	•	•	•			•	•	•
St. Louis U, St. Louis	•				•	•	•			•	•	
Washington U, St. Louis	•			•	•	•	•			•	•	•
Montana												
Montana School of Mines, Butte	•			•			•			•		
Montana State College, Bozeman	•			•	•	•	•			•	•	•
Nebraska												
Nebraska U, Lincoln 8	•			•	•	•	•			•	•	
Nevada												
Nevada U, Reno	•					•	•			•		
New Hampshire												
Dartmouth College, Hanover	•			•	•		•			•		
New Jersey												
Newark College of Engrg, Newark	•			•	•	•	•			•	•	
Princeton U, Princeton	•	•	•	•	•	•	•			•	•	•
Rutgers U, New Brunswick	•	•	•	•	•	•	•			•	•	•
Stevens Inst of Tech, Hoboken	•	•	•	•	•	•	•			•		

The institute of higher education called a college usually offers an undergraduate curriculum confined to the liberal arts, sciences and engineering. Customarily a division of a university, it requires a high-school secondary education for admission. Engineering colleges offering instrumentation courses as part of the curriculum award degrees in electrical engineering, civil engineering, mechanical engineering and chemical engineering.

Graduate schools, too, are usually divisions of a university. They administer programs for degrees beyond the Bachelor's or first professional degree—the Master's and the PhD (Doctor of Philosophy) or DS (Doctor of Science).

Courses in instrumentation listed here are mostly electives in EE, ME, ChE and other engineering programs — that is, they are part of a complete curriculum. While most graduate schools confer a PhD or DS in the various classic branches of engineering, some (asterisks in chart) do offer a specialized PhD in instrumentation — and their number is growing.

*Specialized PhD in instrumentation

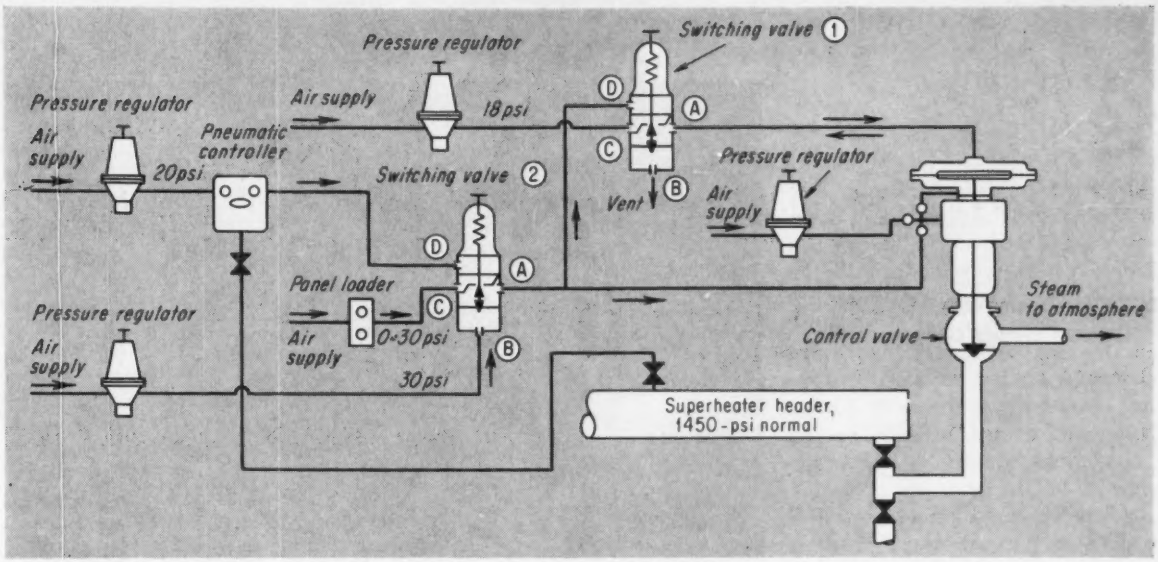
continued

COLLEGES

SCHOOL AND ADDRESS	COURSES: Basic math & science	Process measurement	Product measurement	Automatic control	Data processing & computing	Control test & analysis	ENTRANCE REQUIREMENTS: High-school graduate	Employment in field	Entrance tests	Courses are part of formal engineering curriculum on levels indicated: Bachelor	Master	Doctor
New Mexico												
New Mexico State U, University Park	•	•	•	•	•	•	•			•	•	•
New Mexico U, Albuquerque	•	•	•	•	•	•	•			•	•	•
New York												
Auburn Community College, Franklin	•					•	•			•		
Brooklyn Poly Inst, Brooklyn	•			•	•	•	•			•	•	•
Buffalo U, Buffalo	•			•		•	•			•	•	
City College, New York 31	•			•	•	•	•			•	•	
Clarkson College of Tech, Potsdam	•			•	•	•	•			•	•	
Columbia U, New York	•			•	•	•	•			•		•
Cornell U, Ithaca	•	•	•	•	•	•	•			•	•	•
New York U, New York	•	•	•	•	•	•	•			•	•	•
Pratt Institute, Brooklyn 5	•			•	•	•	•			•		
Rensselaer Poly Inst, Troy	•	•	•	•	•	•	•			•	•	•
Rochester Inst of Tech, Rochester 8	•			•	•		•			•		
Rochester U, Rochester	•						•			•		
U. S. Merchant Marine Academy, Kings Pt	•	•		•		•	•			•		
North Carolina												
Duke U, Durham	•	•	•	•	•	•	•			•	•	•
North Carolina U, Chapel Hill	•		•	•	•	•	•			•	•	•
North Dakota												
North Dakota Agricultural College, Fargo	•			•	•	•	•			•		
North Dakota U, Grand Forks	•				•	•				•	•	
Ohio												
Air Force Inst of Tech, Dayton	•			•	•	•	•			•		
Akron U, Akron 4	•				•	•	•			•		
Case Inst of Tech, Cleveland	•	•	•	•	•	•	•			•	•	• *
Cincinnati U, Cincinnati 21	•			•	•	•	•			•	•	
Dayton U, Dayton 1	•				•	•	•			•		
Ohio Mechanics Inst, Cincinnati 10	•						•			•		
Ohio Northern U, Ada	•			•		•	•			•		
Ohio State U, Columbus 10	•	•	•	•	•	•	•			•	•	•
Ohio U, Athens	•						•			•		
Toledo U, Toledo 6	•			•	•	•	•			•		
Oklahoma												
Oklahoma State U of Agriculture, Stillwater	•				•	•	•			•	•	•
Oklahoma U, Norman	•			•		•	•			•	•	•
Oregon												
Oregon State College, Corvallis	•			•	•	•	•			•	•	•
Portland U, Portland 3	•					•	•			•		
Pennsylvania												
Bucknell U, Lewisburg	•			•		•	•			•		
Carnegie Inst of Tech, Pittsburgh	•			•	•	•	•			•	•	•
Drexel Inst of Tech, Philadelphia 4	•	•		•	•	•	•			•	•	
Lehigh U, Bethlehem	•			•	•	•				•	•	•
Pennsylvania State U, University Park	•	•		•	•	•	•			•	•	•
Pennsylvania U, Philadelphia 4	•	•	•	•	•	•	•			•	•	•
Pittsburgh U, Pittsburgh 13	•			•	•	•	•			•	•	•
Swarthmore College, Swarthmore	•					•	•			•		
Villanova U, Villanova	•					•	•			•	•	
Puerto Rico												
Puerto Rico U, Rio Piedras	•					•	•			•		
Rhode Island												
Rhode Island U, Kingston	•			•	•	•	•			•		
South Carolina												
South Carolina U, Columbia	•			•	•	•	•			•	•	
Tennessee												
Tennessee Poly Inst, Cookerville	•				•		•			•		
Tennessee U, Knoxville	•					•	•			•	•	•
Texas												
Arlington State College, Arlington	•					•	•			•		
Houston U, Houston 4	•				•	•	•			•		
Southern Methodist U, Dallas 5	•			•	•	•	•			•	•	
Texas A & M, College Station	•			•	•	•	•			•	•	•
Texas U, Austin 12	•			•	•	•	•			•	•	•
Utah												
Utah State U, Logan	•				•	•	•			•		
Utah U, Salt Lake City	•					•	•			•	•	•
Vermont												
Vermont U, Burlington	•			•	•	•	•			•		
Virginia												
Virginia Poly Inst, Blacksburg	•			•	•	•	•			•	•	•
Virginia U, Charlottesville	•			•	•	•	•			•	•	•
Washington												
Washington State U, Pullman	•			•	•	•	•			•		
Washington U, Seattle	•			•	•	•	•			•	•	•
West Virginia												
West Virginia U, Morgantown	•			•	•	•	•			•		
Wisconsin												
Marquette U, Milwaukee 3	•			•	•	•	•			•		
Milwaukee School of Engrg, Milwaukee 2			•		•	•	•			•		
Wisconsin U, Madison 6	•			•	•	•	•			•	•	•
Wyoming												
Wyoming U, Laramie	•			•	•	•	•			•		

*Specialized PhD in instrumentation

Of great help in compiling this report were Lloyd Slater, executive director of the Foundation for Instrumentation Education and Research, and Alonzo R Parsons, chairman of ISA's Supplementary Education Committee and coauthor with Steve Elonka of *Standard Instrumentation and Process Control*, to come out in 1962 (Chapter 19 will reprint this roundup). Rufus Oldenburger, Professor of ME at Purdue, supplied data on foreign universities.



3-IN. CONTROL VALVE, right, can handle inlet of 2530 psi at 1050 F, 600-psi discharge. Pneumatic controller operates it as relief valve

Matching steam and turbine temperatures

Control system uses dual-purpose valve to up steam temperature before startup, protect turbine-generator

By R A NEAL and J W TURK
Southwestern Electric Power Co

Central-station design has been changing very rapidly to meet the tremendous growth of the power industry. This growth has produced radical changes in the load characteristics of many systems. Sometimes it's necessary to remove capacity during the night and over weekends, and our Arsenal Hill Power Plant (100,000-kw 1450-psi 1000-F nonreheat turbine-generator) is designed for this operation.

One inherent problem with starting and loading cycles is transient thermal stresses in the turbine shell and valves. If these stresses are large enough to produce plastic strain, a sufficient number of cycles will cause metal cracking. And if steam and turbine-metal temperatures are not reasonably well matched, there is danger of rubbing between the spindle and stationary parts.

One solution: increase the steam-generator flow to bring steam up to turbine-metal temperature. This can be done by installing a remotely controlled drain valve on the superheater outlet.

A 3-in. valve, above, specially designed by the Fisher Governor Company, handles our inlet of 1550 psi at 1005 F with valve discharging to atmosphere. Valve is positioned by a manually operated panel loader in the main control room. Steam flow is controlled from zero to about 100,000 lb per hr, depending on boiler pressure. Wide control range also lets this valve vent the superheater during startups.

Pneumatic controller, above, operates the valve automatically as a relief valve and prevents operation of the other steam safety valves on excess boiler pressure. The controller set-point is 1600 psig; superheater safety valve relieves at 1640 psig.

In normal operation the control valve is closed and the top port of each switching valve is open. Panel loader is manually positioned to vent the superheater or increase superheater flow to match steam and metal temperature. The loader increases air output to the control valve and also to point *D* on switching valve *1*. When pressure increases to 5 psi, upper port of valve *1* closes, opening the lower port and venting the top diaphragm chamber of the control valve through points *A* and *B*. At 6 psi, the positioner starts opening the control valve, venting steam to atmosphere.

Steam flow can also be reduced by the panel loader. When pressure drops below 5 psi, 18 psi enters the top diaphragm chamber of the control valve through switching valve *1*. Seating force of 12,000 lb from top diaphragm chamber produced by the spring and the 18-psi loading gives bubble-tight shutoff against extremely high unbalance (1550-psi drop).

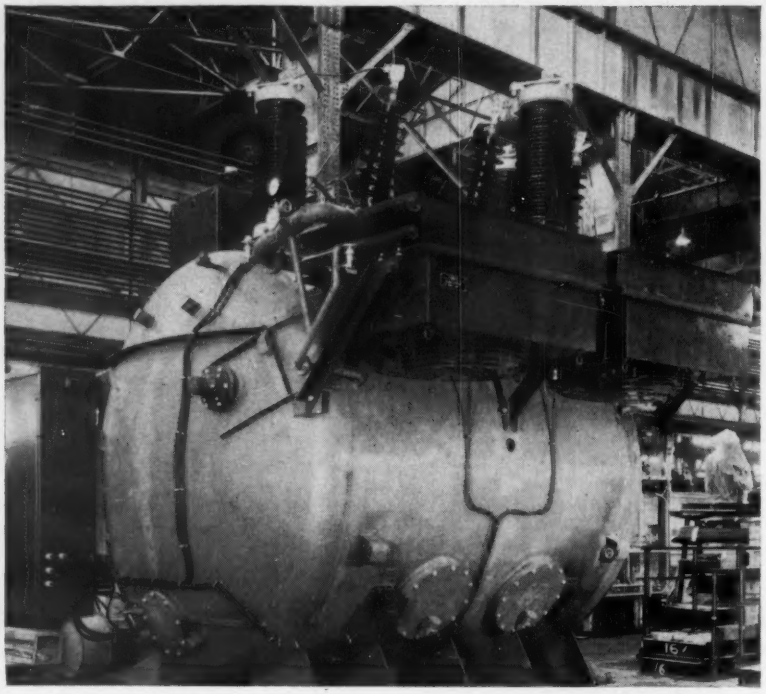
Automatic relief occurs when superheater outlet pressure reaches 1600 psi. At this point the controller transmits 6-psi loading to point *D* of switching valve *2*, closing the upper port and opening the lower one. This sends 30-psi loading to the control-valve positioner and point *D* on switching valve *1*. Control valve's top diaphragm chamber is vented and 30 psi is transmitted to the lower diaphragm chamber, rapidly opening the control valve.

After an overnight shutdown, turbine-metal temperature in the nozzle bowls and steam chest hits about 725 F. With top burners in service and 30-degree up-burner tilt, a temperature of 800 F can be obtained before rolling the turbine.

During 1960 the control valve was manually operated on 34 startups to drain the superheater or increase superheater flow to match steam and the turbine-metal temperature.

By B F ALLEN and W A WOOLDRIDGE
General Electric Company

Nonflammable, nonexplosive insulating gases like sulfur hexafluoride and perfluoropropane compete with the liquids as . . .



POWER TRANSFORMERS in larger sizes have high gas pressure; typical cylindrical tank comes under pressure-vessel code. This unit, rated 9375 kva, 69 kv, uses SF_6 as insulating gas

Gas-insulated transformers broaden their range of application

In the broadest sense, gas-insulated transformers have been designed, manufactured and used for about two decades. First in the field were the air-insulated open dry types. Then a similar unit, but sealed against adverse operating environments, was needed, and sealed-in-nitrogen dry type transformers were the answer.

Development got a big push from the introduction of Class-H insulations incorporating silicone resins and varnishes. Even though these insulations allowed operation considerably above liquid-filled-transformer temperatures, physical dimensions and weights were generally greater than for the comparable liquid transformer. In addition, nitrogen-filled transformers had less impulse strength than their liquid-filled counterparts. These limitations have restricted the nitrogen-filled transformer to relatively small kva sizes and to circuits of 15 kv or below.

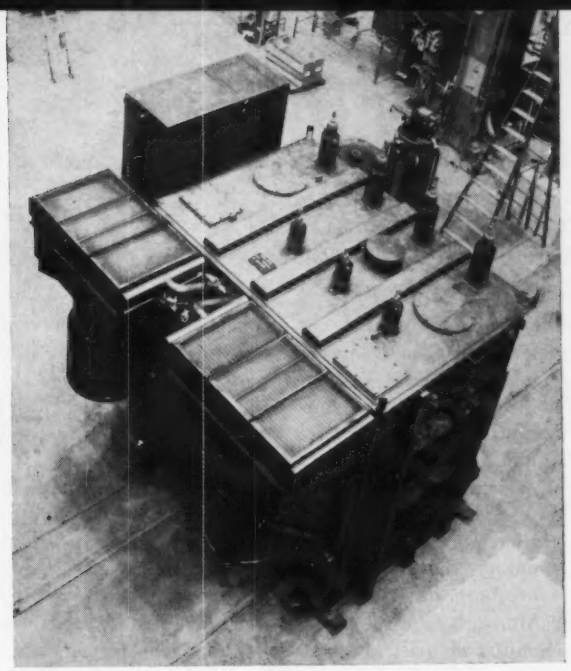
With the coming of high-dielectric-strength gases—the widest-known of them being sulfur hexafluoride (SF_6)—it became possible to design gas-insulated transformers for high circuit voltages and large kva sizes. A 10,000-kva 69-kv unit has been operating on the Pennsylvania Power and Light Company system for some time.

A prior POWER article (*Gaseous insulation goes to work*, by G Camilli, July 1959, pp 62 to 66) discussed in some detail the characteristics of high-dielectric-strength gases in use or under consideration as transformer insulating and cooling mediums. In this article we'll look primarily at application of two of these gases in transformers designed for industrial and utility-system applications under present conditions.

The earlier article pointed out that dielectric strength and cooling characteristics are functions of gas pressure (density, to be more exact). It explained what these pressures are for different applications and why they were selected. Reasons for choosing one gas in preference to another for a given class of applications were discussed. Finally, applications and ratings and types of equipment offered on a commercial basis were given.

Why gas instead of the askarels? Although much has been said about gas because of its nonflammable characteristic, the askarels also have this property. Gaseous dielectrics, however, have the advantage when explosion resistance and weight count. They also make it possible to design transformer more effectively when special low sound levels are required for a particular location.

As it does in an oil unit, an internal arc in an askarel-filled transformer causes considerable pressure to develop because of thermal decomposition of some liquid into gaseous products and because the liquid won't compress. Resulting pressure can rupture the tank. Tests indicate that this hazard is eliminated when gas



LOW-PRESSURE insulating gas permits a conventional design for smaller power transformers. This one, 7500 kva, 46 kv, uses SF_6

DISTRIBUTION or secondary-substation transformers without heat exchangers use C_3F_8 for its better high-temperature characteristics

is substituted for the liquid. At the time of the arc or failure, pressure developed in a gas-filled unit is very small compared to that in a liquid-filled unit. In industrial applications where the transformer has to be indoors and is closely associated with other equipment, nonflammable and nonexplosive features are vital.

Nitrogen-filled transformers have the nonflammable and nonexplosive features, but they've been rejected for many applications in favor of askarel-filled units because of their lower impulse strengths. Using high-dielectric-strength gases, gas-insulated transformers can now be designed with impulse characteristics very close to those of liquid transformers. At the most, a BIL one step down from that of a comparable liquid transformer is necessary. As a result, commercially available lightning arresters give adequate protection.

Reductions in weights and physical dimensions are always welcome. Mining-rectifier units, for example, must be lowered into shafts and moved through tunnels with small clearances. So any reduction in size and weight is a help; it reduces the size of equipment required to move the transformer. In industrial installations, too, size and weight are important. The high-dielectric-strength gas-filled unit is measured against two existing yardsticks: the nitrogen-filled and the liquid-filled (primarily askarel) transformer.

In the usual range of 300 through 2000 kva, the high-dielectric-strength gas-filled transformer ranges from a little bit to as much as 30% lighter than nitrogen-filled units. In the 500- through 2000-kva range, the high-dielectric-strength gas transformer is as much as 20% lighter than an askarel unit.

Sound levels, particularly those of substation transformers, are important to utility companies because, as a matter of necessity, substations are creeping closer to residential areas than ever before. And in many industrial applications, transformer sound level is important. Since gas is a very poor transmitter of magnetostrictive core vibration compared with liquids, it offers better sound reduction. For instance, a recently shipped 7500-kva unit was designed for and tested 9 db lower than NEMA-recommended values. Of course, sound level is not a function of insulating medium alone.

Insulating gases are stored and shipped in the liquid state at their vapor pressure for the prevailing ambient temperature. This gives an advantage apart from primary insulating and cooling functions—tremendous volume reduction compared with insulating liquids can be important when you're considering requirements for repair facilities, since large liquid-storage tanks aren't needed. There are no personnel hazards or unpleasant handling conditions associated with insulating gases used to date under normal circumstances. Spills or equipment leaks don't soil the installation. And in the unlikely event of a transformer leak, drainage pits or floor drains plus subsequent cleanup are unnecessary—leaking gas merely escapes into the surrounding atmosphere and disappears.

continued

Two insulating gases prove practical so far

Barring leaks, the insulating gases never need reconditioning. Maintenance usually boils down to periodic physical inspection of the transformer exterior and its electrical connections. If your power transformers involve a large quantity of gas, or for other economic reasons, you may decide to keep equipment on hand to remove the gas. To do the job, you'll need a vacuum pump, compressor, storage cylinders and a means for removing or supplying latent heat of vaporization, depending on whether the gas is being put in or taken out of storage bottles.

Why two different gases? The two used to date are sulfur hexafluoride (SF_6) and perfluoropropane (C_3F_8). SF_6 has a boiling point of –63.8 C at atmospheric pressure while C_3F_8 boils at –36.7 C. SF_6 is stable thermally up to about 150 C in the presence of most transformer materials and C_3F_8 holds up to about 275 C under the same conditions.

First commercial transformers using high-dielectric-strength gas were designed for sulfur hexafluoride (SF_6). These units were relatively large-kva sizes with primary voltages of 69 kv or above. In this class of equipment, heat exchangers, involving rotating equipment, are generally acceptable for dissipating the transformer losses. And so it is feasible to design for relatively low temperature rises, well within the capabilities of SF_6. In some instances, required insulation level was achieved by filling the transformer to a relatively high pressure at ambient temperature rather than using the larger electrical clearances that would have been required otherwise. In such cases, SF_6 is more desirable because its lower boiling point insures safe startup at lower ambient temperatures which may be encountered.

But in many applications, heat exchangers involving rotating equipment are unacceptable. At the same time these applications require minimum size and weight. To meet these needs, self-cooled high-temperature (150-C average winding rise) Class-H-insulated designs are required. So a fluorocarbon gas such as C_3F_8 meets the requirements of these designs because of its high-temperature compatibility with materials of construction. Its boiling point of –36.7 C provides safe startup with moderate filling pressures.

You should have no particular objection to handling the gases, even though two or more different ones are needed. Although two gases are used, the amount you must keep on hand will only be a few lb—a small cylinder—or at most two or three cylinders per type of gas, depending on transformer size and number of units. The spare gas is used to keep density up to that at initial filling, and only a few cc per month are likely to be lost—due to permeability of the gaskets, welded joints and so on. Storing this amount won't be much trouble compared to the gallons of oil or askarel that often must be kept.

Pressure (more exactly, density) selection is dictated by size, voltage rating and kva capacity. As the density of the gas increases (up to a certain value for a given set of electrodes) the insulating distances required are reduced, making the unit smaller. As density increases, associated cooling equipment becomes smaller and less complicated. However, when you reach a density that requires 15 psig or higher, you'll have to consider the ASME Unfired Pressure Vessel Code. At this point, construction of the tank becomes the prime requisite for operation.

When all of these factors are considered, best solution appears to be operating at a pressure that stays below 15 psig on overload but gives adequate dielectric strength and cooling to keep the unit within reasonable size limits. At present, optimum filling pressures seem to be about 2 to 3 psig for portable rectifier transformers, approximately 5 psig for industrial units, and 5 to 7.5 psig for substation power transformers.

Applications are widespread. Power-company uses for gas-filled transformers include substation power transformers and auxiliary supply transformers for power in generating stations. A Class-H C_3F_8-insulated network transformer has also been supplied to get experience in network system operation.

A large area for industrial application: load-center unit substations where one or more transformers and their switchgear are close to the loads in an industrial plant. In these industrial installations askarel and nitrogen-filled transformers are now widely used. Fluorocarbon-gas-filled Class-H units offer insulation levels comparable to askarel plus smaller sizes and weights than nitrogen, and they don't sacrifice the nonflammable, nonexplosive features of present nitrogen-filled transformers.

Current units are being offered in the 300-to-7500-kva range for industrial transformers and some utility applications. They run up to 50,000 kva, 69 kv for the substation type of power transformer.

The gas-insulated transformer's advantages make it particularly desirable for certain kinds of installations: unit substation transformers and rectifier units located inside industrial plants; generator transformers and station service transformers in generating stations; mining rectifiers and ac power-supply transformers; network transformers either inside a building or in street vaults; outdoor substation transformers in congested areas or wherever noise is a factor.

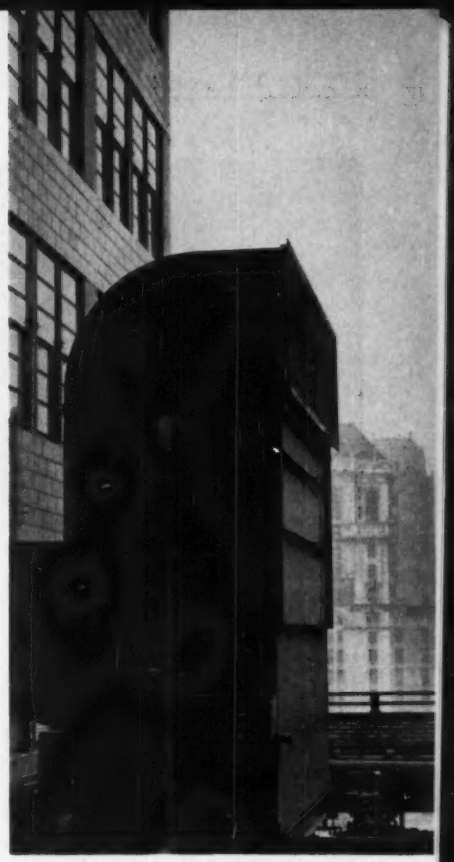
Modernization and new construction programs make these installations more and more common. Further development of gas-insulated transformers should broaden their field of use still more.

These references are all in *AIEE Transactions*: "Sealed dry type transformers proved safe by test," E W Tipton, Vol 72, Pt III, pp 843-848. "Internal fault characteristics of gas-insulated transformers," G Camilli, L G Littlejohn, W A Wooldridge, Vol 78, Pt III, pp 1779-1784. "Insulation coordination of gas-insulated transformers," G Camilli, R E Coates, Vol 77, Pt III, pp 220-224.

Cooling towers will scrub out air pollutants in urban or industrial areas while cramped quarters call for the shoehorn technique: These are two special problems you must consider in design and choice of materials for . . .

Cooling towers to handle big-city duties

By Dr SIDNEY SUSSMAN, Chief Chemist, Water Service Laboratories, Inc



URBAN COOLING TOWER scrubs out air pollutants; pan sludge builds up

Design engineers will run into some special problems in planning cooling towers for urban locations. These are frequent problems, and if not anticipated, they can be major causes of shortened cooling-tower life and severe operating troubles. They stem largely from two factors: atmospheric pollution and economic limitations.

Atmospheric pollution includes solid particles as well as the less visible but sometimes more damaging flue gases.

Economic limitations may pose more than the relatively simple problem of the high cost of city space. Satisfactory space may be almost impossible to come by when cooling towers must be tucked away in nooks and crannies of existing buildings.

The owner of an urban building generally has little knowledge of operating or maintaining his mechanical equipment. He tends to overemphasize low initial price, underemphasize adequate, reliable operating and maintenance help. In some cases, careful design and operation of the cooling tower and water system are enough to correct the difficulties. Elsewhere design engineers will have to justify more-expensive equipment features to their clients. Here, a clear understanding of the situation will help.

In recent years, extent of the air-pollution problem in urban areas has been more generally recognized. In large cities, total pollution discharged into the atmosphere daily is incredibly large. Estimates have it, for example, that fuel combustion pours about 2,000,000 tons of sulfuric acid into New York City's atmosphere in the course of just one year.

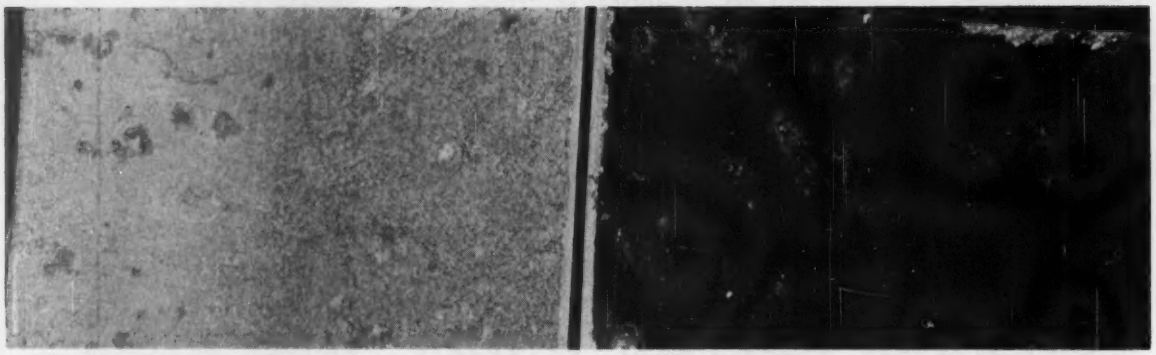
As air scrubbers, cooling towers are very effective. In a highly polluted atmosphere, a tower will scrub approximately 350 cu ft of polluted air per minute for each ton of its cooling capacity. Let it do that, and you're walking into situations which many system design engineers have never taken time to consider.

In areas of heavy dust and dirt concentrations, muck-like deposits build up in cooling-tower pans at a rate of an inch or more per week. Circulating water, too, becomes saturated with dissolved gases from the air. A gas that occurs naturally, such as oxygen, is troublesome enough when so dissolved, but when the atmosphere also includes appreciable amounts of acid-making flue gases like SO_2 and SO_3, corrosion of cooling towers and water systems increases at a fantastic rate.

This is particularly true when makeup water is low in alkalinity, as it is in New England and the Middle Atlantic states. In New York City, for example, 77% of circulating-water samples from 1500 towers receiving no water treatment had a pH below 7—the water was acidic. Some pH's dropped as low as 2.5! Effects of these acid conditions contrast with those produced by the scale which commonly forms in cooling-water systems in areas with hard, high-alkalinity water.

Removal of either gaseous or solid impurities before air enters the cooling tower is usually economically impossible, although even this extreme step must be taken on rare occasions. In one case it was actually necessary to install screens on the cooling-tower air intakes in a fur-manufacturing district. This was the only way to keep fibers from entering and clogging circulating-pump intake screens.

Materials of construction are the first consideration in design of the equipment itself. It's usually too expensive to try to eliminate all corrosion problems through corrosion-resistant materials. And even where these materials are used, you can't assume that you'll automatically overcome all corrosion difficulties. An all-stainless-steel cooling tower, installed at a location where solids pollution was heavy, failed when the muck layer formed in its pan. Muck had a reducing effect, destroying the metal's natural protective film and resulting in severe pitting. On the other hand, stainless-steel cooling towers have worked successfully with mild-steel pans protected by suitable painting or other coating. No one hard-and-fast law has been laid down to cover all situations, but there are some stand-



ALUMINUM PIPING failed at upstream end because copper from condenser coils deposited there. Solution: an expendable spool piece at the beginning of the aluminum section, long enough to cover the corrosion area. Cleaned section, left, shows corrosion

ard design rules for minimizing corrosion to keep in mind.

Avoid couples of widely dissimilar metals (particularly aluminum and copper), crevices, horizontal shelves, other potential sources of localized corrosion.

Review materials used in the tower and associated equipment to make sure that all components are compatible with water treated with the usual chemicals: polyphosphates, chromates and nitrites. Materials must hold up even when these chemicals are present in uncommonly high concentrations as a result of poorly controlled water treatment. Equipment should also be capable of withstanding a relatively wide range of pH—6.5 to 9.5 or 10—with these chemicals present.

Solid particles that promote local corrosion in a cooling-tower pan can do equal or greater damage in the circulating cooling-water system. Low water velocities in condenser tubes let particles settle out and interfere with heat transfer or start local corrosion cells. Many particles are abrasive and shorten the lives of pump shafts and mechanical shaft seals.

Proper design always calls for a strainer on the cooling-water line before pumps or condenser, but even so, much damage is done by particles small enough to sneak through the strainer. Sometimes you'll need to rinse or lubricate bearing surfaces with clear makeup water. In extreme cases you can control fine solids by installing a bypass filter to continuously filter anywhere from 1% to 3% of the circulating water.

To lessen hazards of airborne dirt and water loss on shutdown, the cooling tower should be designed with a deep pan or reservoir. The deeper the pan, the more dirt which can settle out in it for later removal during maintenance cleanings—and unless this pan is deep enough to hold all water contained in the head pan, in overhead piping and in mid-air during operation, water will overflow and be lost when the tower is shut down. In addition to the waste of water and treatment chemicals, such periodic loss makes it harder to bring water treatment to the proper level on restarting.

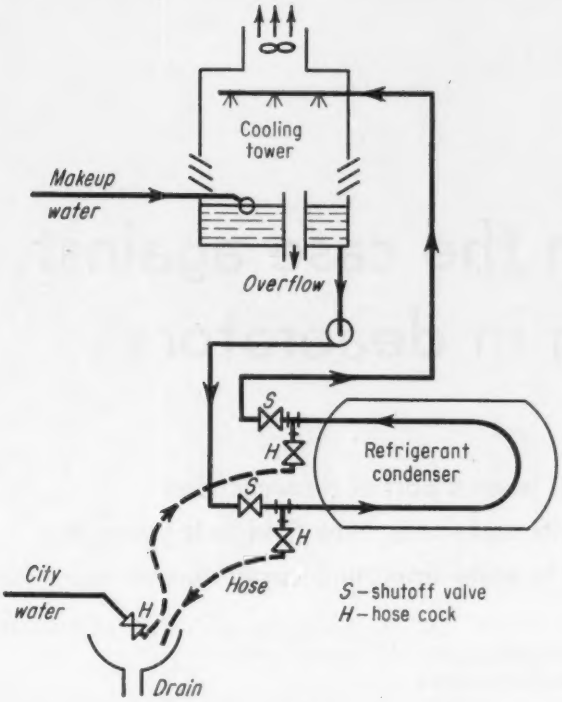
Key to effective water treatment is treatment control, and so any unnecessary water loss must be avoided in the design and operation of a cooling tower. Every drop of water that's wasted carries with it expensive chemicals. Probably the most often overlooked source of potential water loss is a tower inadequately sized for its cooling capacity. An undersized air-conditioning tower tempts the operator to supplement normal cooling with free-flowing makeup water when the system proves inadequate on hot days. Resulting loss of water in continuous overflow makes a mockery of installing a cooling tower in the first place. It's best to leave some margin—too-close design-capacity figuring can lead to difficulty because even a slight fouling of condenser surfaces by scale, sediment or slime will then force a shutdown of the equipment.

Built-in bleeds provided by manufacturers are very helpful in avoiding scale formation in hard-water areas, but they're not designed to use water most efficiently in every location. More usually they are rather wasteful of water and chemicals. So instead of such devices, specify controlled blowdown wherever necessary. In some areas the water composition is such that normal windage or drift will purge dissolved solids enough to keep the circulating water from forming scale. In all cases, however, a competent water chemist should be consulted to determine water-treatment chemicals and bleed rates.

Twin cooling towers are used in many systems, each supposedly handling about half the cooling load. These can be another problem in urban installations. One common body of cooling water supplies the towers, but there are two distinct pans, so any hydraulic unbalance between towers results in overflow of treated water from one pan and excessive makeup demand by the other. This is easily avoided by connecting the two cooling-tower pans with an equalizing pipe sufficiently large to have minimum friction drop with any likely intertower flow.

A special situation is encountered in towers located on a lower-story setback with water lines running upward to condensers on higher floors. These water risers need check valves to prevent loss of treated water every time the cooling tower shuts down. Then it won't take excessive makeup to refill the system on startup.

Equipment size in urban air-conditioning or refrigeration systems frequently permits off-the-shelf pur-



HOSE CONNECTIONS and shutoff valves initially installed on cooling lines permit ready backflush of refrigerant condensers

Air pollution alters cooling water

	Worcester, Mass.		New York City	
	Makeup	Tower	Makeup	Tower
pH	7.4	4.6	7.1	4.8
Alkalinity, ppm	8	2	10	16
Sulfate, ppm	8	400	10	4800
Chloride, ppm	5	68	4	326
Iron, ppm	0	4.4	0	63
Copper, ppm	0	0.7	0	2.2
Zinc, ppm	0	10	0	2800

SO_4 AND Cl BUILDUP comes from scrubbing polluted air. Reduced pH in cooling water causes severe system metal loss

chase of cooling towers. But the system design engineer still has the responsibility of locating and installing the units to avoid operating difficulties. If at all possible, he should consider the physical relationship between proposed location of a cooling tower, prevailing wind and nearby air-pollution sources such as stacks or incinerators. Placing a cooling tower downwind from a stack is just asking for trouble. In other cases it may be necessary to raise the height of a stack in order to prevent the cooling tower from acting as a scrubber for all the acid flue gases.

Windage and drift can never be completely eliminated from a cooling tower, although natural-draft towers suffer more than the induced-draft designs. Windage, collecting on nearby structures, causes unsightly wet spots. When a wood-fill tower is new, circulating water frequently contains dye extracted from the wood, which will produce dark stains, and most circulating water, even though it's treated, contains some suspended rust which can also stain surrounding buildings. Unfortunately, the most effective corrosion inhibitor, chromate, is bright yellow, and can make even more of a mess. So the design engineer must locate cooling towers at some distance from any light-colored building or other structure which could be defaced by staining.

Drift is sometimes a nuisance in urban areas because the droplets fall on cars. There they evaporate, leaving tiny spots of solids which were originally dissolved in the water. A wind screen may help alter the flow of air from a cooling tower and minimize this problem.

Cooling-tower designers should recognize that efficient operation requires frequent maintenance—feeding water-treatment chemicals, repair and regular cleaning to remove dirt, algae, slime or other materials which accumulate and ultimately interfere with operation. Therefore, convenient access panels or doors are a must. To save time, liberal use of "dogs" or wing nuts is preferred over sheet-metal screws wherever possible on these access openings.

When a cooling tower is placed on an existing building, particularly when it must mount at an angle on the corner of the roof, access takes special thought. Tower will need draining and cleaning once a year if not more often. Provide for getting rid of the drainage and for reasonably convenient hose connections.

To ease cleaning, equip both inlet and outlet water lines on individual condensers with valved tees as well as shutoff valves so that each condenser can be isolated from the circulating-water flow and back-washed to remove airborne dirt, or cleaned with a detergent to remove slime, inhibited acid to get rid of scale.

These are major pitfalls to be avoided in the big city, but by no means all of them. Each location may have more-specialized problems as well. Before designers of cooling towers and air-conditioning and refrigeration systems can begin to cope with these problems, they should be prepared—alert to the special conditions they must consider.

Tests strengthen the case against antiflash baffling in deaerators

Since the 1940's, antiflash baffling has been a part of recommended deaerator design. But many doubted its usefulness. Now field tests prove its inadequacy, point up actual dangers in some operating circumstances

By I J KARASSIK and L E ZABEL, Worthington Corporation, and
R A NEAL, Supt of Plant Design, Southwestern Electric Power Co

It would seem that the subject of whether antiflash baffling should be used in the storage space of deaerators could be considered exhausted by now—so much has been published on it. But the question refuses to move backstage and become a historical curiosity. As a matter of fact, it threatens to heighten in controversial stature and to split both power-plant engineers and equipment designers into two almost hostile camps. And so we feel that the time has come to review all the evidence at hand, provide necessary additional data and examine the case for or against antiflash baffling so as to reach a final verdict. It is probably unsporting to reveal our verdict before you have had a chance to examine the evidence, but the need for a title takes the matter out of our hands.

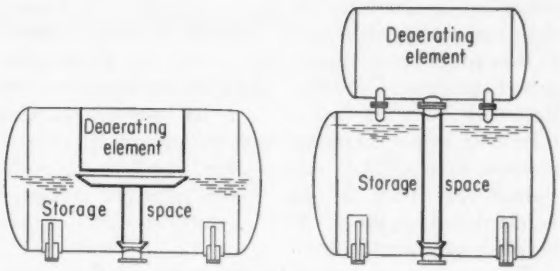
Approaching this final verdict, we reviewed all pertinent literature, together with the whole history of antiflash baffling, which is a structural modification of deaerator storage space designed to lessen unfavorable effects of sudden load reduction on temperature and pressure at boiler-feed-pump suction. Then, to wrap up the verdict, field tests were run on two otherwise identical deaerators—one with antiflash baffling and one without—at the Lieberman Station of Southwestern Electric Power.

But before detailing test results at Lieberman, let us first see just how antiflash baffling came to be an accepted part of modern deaerator design.

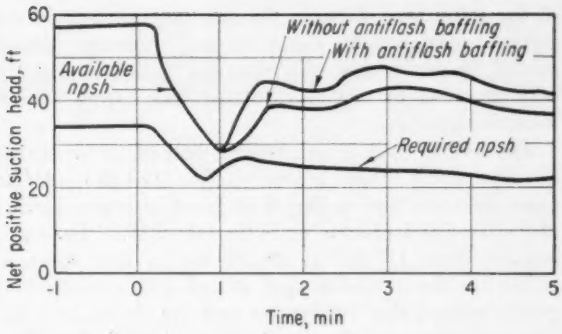
Before World War II, deaerators were generally operated at moderate steam pressures and temperatures. Deaerator pressure, furthermore, was frequently pegged to avoid variation when the main turbine load changed. Later, two parallel developments took place: (1) steam supply to deaerator more generally came from a bleed stage of the turbine, so deaerator pressure changed almost directly with the load (2) design pressure at rated load increased appreciably in successive new station designs. With time, reports started coming back to boiler-feed-pump builders of an alarmingly increasing number of pump difficulties related to flashing in the pump suction: steam binding and internal parts seriously damaged through contact and seizure. When enough cases had been analyzed, it became apparent that pump failures were somehow associated with sudden reductions in station load.

A diagnosis of this association was presented to an ASME meeting in 1944 by I J Karassik (first paper in bibliography, p 91). On a severe and sudden drop in station load, a turbine's first tendency is to overspeed, because it is receiving excess steam. But the turbine governor immediately acts, throttling the steam supply to the turbine and holding turbine speed at its rated value. Consequence of this reduction in pressure at the turbine steam inlet: a proportionate reduction at the bleed stage supplying the deaerator. The extraction line between deaerator and turbine bleed point is provided with a check valve. Since the deaerator is a reservoir of hot water, it will not reduce pressure as rapidly as the turbine extraction point. And so the check valve in the bleed line closes, isolating the deaerator from the turbine until some later time when deaerator pressure decays to bleed-stage pressure for the new reduced load.

Even though deaerator pressure drops more slowly than that of the bleed stage, *it still will drop.* And this reduction transmits almost instantaneously to the pump suction. But the corresponding change in feedwater temperature does not take place until colder water from the deaerator has had time to flow through the suction piping and arrive at boiler-feed pump's first-stage impeller. During this interval, available npsh goes down by an amount which reflects the difference between vapor pressure of the feedwater preceding the sudden load drop and reduced



ANTIFLASH BAFFLING carries feedwater directly from deaerating element to boiler-feed-pump suction line, bypassing storage



SUDDEN LOAD DROP causes immediate deaerator pressure drop below saturation. Npsh safety margin can get dangerously low

pressure in the deaerator immediately following the drop.

The 1944 report didn't measure the effect of a sudden load drop on available npsh. It merely stated that higher normal operating pressures in the deaerator would produce more severe unfavorable effects. So it suggested that power-plant designers add some safety margin over the required npsh under stable conditions. The paper also stated that cold water might be injected at pump suction as a protective measure, and suggested how this injection might be controlled automatically. Later on, such an automatic control was developed, either to inject cold water or admit auxiliary steam. This allowed a more orderly rate of pressure decay in the deaerator.

In a discussion of this ASME paper, alternate protection against effects of sudden load reduction was described. Idea was to provide baffling immediately below the deaerating element, along with some internal piping, so as to conduct feedwater directly from the deaerating element to the outlet nozzle of the storage space. If there was more feedwater than boiler-feed pump demanded, an annular clearance at the bottom of the storage space between downcomer pipe and outlet nozzle would let it spill into the storage space. Conversely, any excess in demand over deaerated flow could be made up from storage through the same clearance. And this is how antiflash baffling appeared on the scene.

Theory of this antiflash baffling: since water leaving the deaerating element is always at a temperature corresponding to pressure in the deaerator's steam space, it will be cooler during the load drop than water taken from the bottom of the storage compartment. And so, being cooler, it will act to reduce—if not eliminate entirely—unfavorable effects the sudden load drop has on available npsh.

Curves of deaerator pressures and values of available npsh after a load drop, taken both before and after antiflash baffling was installed, went along with this discussion. Strangely enough, the after-installation curve indicates that deaerator pressure dropped from 73 to 35 psia in less than 10 minutes, while *available npsh was not reduced at any time.* Hindsight, of course, is notoriously sharper than foresight, but it is difficult to understand now why nobody ever questioned these curves. After all, at least during the time that the suction piping had to be voided of the feedwater it originally contained, vapor pressure at the pump suction remained constant while heater pressure was dropping at the rate of almost four psi per minute—and boiler-feed-pump suction pressure, as well, was dropping during this period.

Unfortunately, the beneficial effects of antiflash baffling were not questioned seriously. At most, the conclusion of the ASME paper sounded some warning of a possible side effect of antiflash baffling: "One of the features of this solution which remain to be investigated resides in the effect of the baffling arrangement on installations embodying very large feedwater storage volumes, where such baffling may lead to excessive subcooling of that portion of the stored feedwater which is farthest removed from the heater outlet." But apparently this feature did not get much further thought, and antiflash baffling became quite prevalent throughout new steam-power-plant installations. Its exact configuration varied somewhat with different deaerator manufacturers, but essentially it followed the typical arrangements above.

Efficacy of antiflash baffling in protecting boiler-feed pumps against transient operating conditions was apparently accepted, despite the accidents reported even in stations supposedly so protected. In explanation, it was generally claimed that transient conditions were so severe that even antiflash baffling had been powerless.

First hint of trouble—that antiflash baffling did too little and did it too late—came in a 1952 paper: "The net

effect on the allowed rate of deaerator pressure decay will be equivalent to elevating the deaerator by the amount of the static head between the feedwater surface in the storage space and the outlet nozzle." Although unsupported by test results, this certainly indicated that the help provided by antiflash baffling was hardly of tremendous significance.

The need to develop quantitative methods of predicting the deaerator's behavior after sudden load drops led to some elaborate tests at the Moss Landing Steam Station of Pacific Gas & Electric Co in the fall of 1953. Load was reduced from 117,500 to 28,000 kw in 10.5 seconds; results on the available npsh at one of the boiler-feed pumps serving this 100,000-kw unit are shown on p 87. This part of the test examined effects of antiflash baffling on available npsh. It showed that baffling only begins to help when feedwater which was leaving the deaerator at the instant the load drop began (time = 0) reaches the pump (in this case, time = 1 min).

And yet, both a theoretical analysis of the problem and the field-test verification of this theory indicate that the critical period occurs at the end of residence in the suction piping, at the moment when the antiflash baffling just starts taking effect. This is obvious from examination of the curve, which shows that the margin between available npsh and that required by the pump reaches a minimum at the *end* of the residence time. From that moment on, even though pressure in the deaerator may continue to drop, feedwater entering pump suction will be progressively cooler and will therefore have a progressively lower vapor pressure.

If trouble is likely to develop at or before the critical moment in this boiler-feed-pump installation, antiflash baffling will not be effective; it won't ward off trouble early enough. But if the boiler-feed pump can get through that difficult moment by itself, it has little need for further help.

Such were the conclusions reached in 1953. But because there was no suspicion as yet as to the potential hazard that could be a side effect of antiflash baffling, little effort was made to dissuade power-plant designers from demanding baffling in the deaerators they were purchasing. At worst, went the general belief, the user paid for extra labor and materials which gave him doubtful returns on his investment. But there were a few power-plant designers who suspected these side effects; throughout this period they insisted that violent mixing in the storage space would be extremely desirable.

A more thorough review of the problem seemed justified by 1959. Based on strictly theoretical considerations, it lacked the supporting evidence of a test program; conclusions were based on this premise: antiflash baffling leads to feedwater stagnation in the storage space because all feedwater coming to the boiler-feed pump is led directly from the deaerating element to the outlet nozzle through the internal downcomer. This causes appreciable subcooling in the storage space and a certain amount of stratification, with the coldest water settling to the bottom layers and the hottest water at the top.

But if feedwater in the storage space is thoroughly mixed and at a uniform temperature approximately equivalent to deaerator saturation pressure, any drop in deaerator pressure will be accompanied by violent flashing in the storage space. Steam thus released will immediately retard the rate of pressure decay in the deaerator. On the other hand, if feedwater in the storage space is materially below saturation temperature, an appreciable pressure drop will take place before any flashing in the storage space and therefore before pressure reduction is retarded. Thus the ill effects of a sudden load drop are seriously aggravated.

Theory was verified in practice not long after, through two reported and authenticated field experiences. In the most dramatic one, tripout tests in a Japanese steam power plant were conducted immediately after a cold startup. They showed that when a unit is brought up to full load rapidly, water temperature in the storage space lags considerably behind the temperature of feedwater flowing to the feed pump through the internal downcomer from the deaerating element.

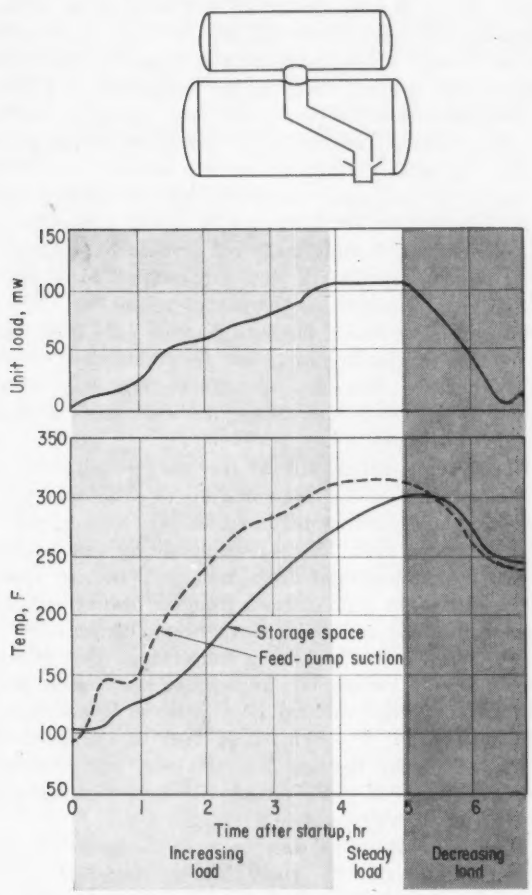
Observations made during these tests showed that by the time the unit was at full load, water in the storage space was about 35-F *below saturation temperature*, while water at the pump suction was *exactly at saturation temperature*. Under these conditions, it was obvious that the deaerator pressure would have to drop about 35 psi before flashing in the storage could help moderate the rate of pressure decay. As a result, this 35-psi pressure drop was seen to be almost instantaneous. Since the installation did not provide 80-ft excess npsh (equivalent to the 35-psi pressure drop), flashing took place in the system and the boiler-feed pumps were seriously damaged. The engineers who had designed this Japanese steam plant, and who had conducted the tripout tests, were readily convinced of the unfavorable effect of antiflash baffling. They removed it, and subsequent tests proved that with no baffling, there was no flashing in the pumps.

Publication of these findings created considerable controversy in the technical press. Supporters of antiflash baffling took somewhat varying positions. There were those who felt that baffling had been reported as helpful in certain cases and should therefore continue to be used, with automatic protective controls added to obviate any ill effects. These controls would operate an admission valve in an auxiliary steam line to peg the rate of pressure decay in the deaerator. They would also limit the rate at which cold condensate is admitted to the deaerator, since this cold condensate contributes materially to the pressure reduction after a sudden load drop.

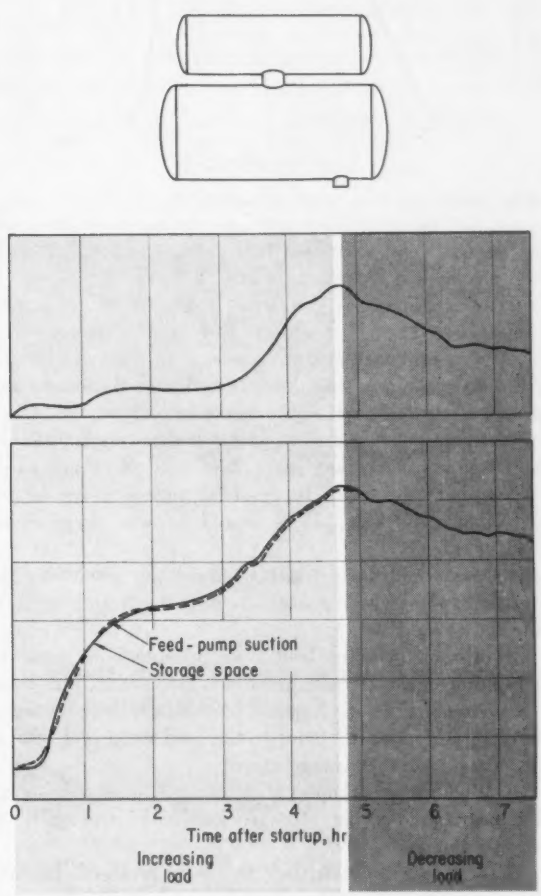
Others claimed that feedwater cannot stratify in the storage compartment, because in normal operation a thermal potential in the storage tank causes circulation and mixing. Another faction maintained that while some designs contribute to stratification, others permit cross-

Compare deaerator storage temperatures

Deaerator with baffles



Deaerator without baffles

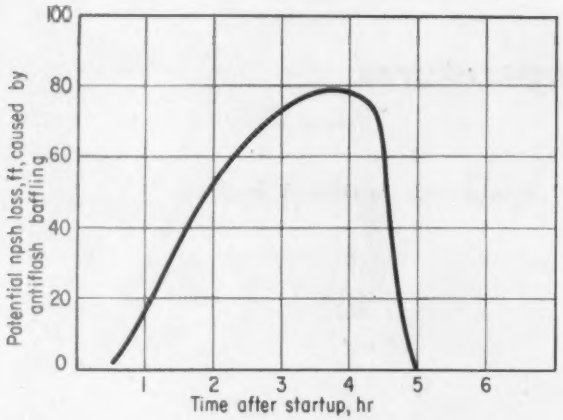


EFFECT OF ANTIFLASH BAFFLING shows up dramatically in this direct comparison of storage-space and boiler-feed-pump temperatures. In unit with antiflash baffling, left, storage lags boiler-feed-pump temperature throughout entire startup time

flow between the freshly heated feedwater proceeding down the internal downcomer and that already in the storage space of the deaerator.

What shall we say in answer to these arguments? To the one which cites cases where antiflash baffling helped, we can only repeat that, both theoretically and on the basis of field tests, baffling can only be of assistance *after* the critical moment has passed. If protective controls are to be added, they make baffling completely unnecessary. We should emphasize that we are not at all opposed to the application of protective controls. If there are good reasons to forego natural protection through the use of adequately sized deaerator storage space and properly sized suction-piping volume, or if the economics of the situation make protective controls the justifiable solution, use them by all means.

Whether some antiflash baffling promotes better mixing than other designs is debatable. But even if true, it only means that slightly less stratification takes place on one hand and that baffling is used slightly less effectively



NPSH LOSS caused by antiflash baffling can far exceed design margin. And this trouble potential may continue hours after start

after the residence time has elapsed and the newly deaerated feedwater reaches the feed pump.

Finally, since arguments on whether stagnation of feedwater in the storage space does take place persisted, we felt that they could be resolved once and for all by controlled field tests. Tests would answer three basic questions:

(1) Does antiflash baffling cause the feedwater to subcool in the storage space? By how much and for how long after a cold start?

(2) Does subcooling lead to an instantaneous pressure drop in the deaerator after a sudden load reduction? Does this pressure drop correspond to the difference between the deaerator pressure prior to the load drop and saturation pressure in the storage space?

(3) If antiflash baffling is eliminated, does subcooling disappear and is the storage feedwater essentially at saturation temperature?

Lieberman Station of the Southwestern Electric Power Company has deaerators serving Units 3 and 4, ideal for these tests. While the two units are designed for duplicate operating conditions, the deaerator serving Unit 3 has no storage-tank baffling, while the deaerator for Unit 4 is equipped with standard antiflash baffling.

Both units are rated 100 mw. Deaerators are tray type, rated for 670,000 lb per hr. Storage capacity is 15,000 gal (equivalent to about 10-min storage at rated load). Steam for these deaerators comes from the third extraction point of the main turbine and therefore, as usual, the deaerator pressure varies with the main turbine load. At full load, their design operating pressure is 71 psia. They are installed outdoors and fully insulated.

Obviously, this could not be a laboratory type of test; accumulation of data had to fit into normal plant operation. The only modification was in the way storage-tank temperatures were measured, since tanks had been de-

Lieberman Station deaerators

signed without special provisions for such measurement. To avoid the costly and undesirable modifications to an ASME-certified vessel that adding connections for temperature instrumentation would involve, existing gage-glass taps were used. Water from the storage tank was drawn off the bottom connection and returned to the top connection. A thermometer was installed in this temporary piping. To give a more accurate indication of stored-water temperature, a small pump in the line maintained flow.

Test data was needed under three operating conditions to fully tell the tale: (1) during a normal plant startup (2) during a period of steady maximum load (3) during a normal plant shutdown. System loading was just right on Dec 19, 1960; all three test phases could be completed by coming up to full load (actually to 5% over full-load rating) and then dropping off to no load. To provide a clearer comparison between the various temperatures, deaerator pressure readings have been converted to corresponding saturation temperatures in curves on p 89. The curves show immediately that subcooling, suspected to exist in the storage feedwater after a plant startup, is definitely a fact.

During the startup part of the test, temperature at feed-pump suction did not come up to saturation temperature corresponding to deaerator operating pressure for quite some time. This was probably because a little of the colder feedwater from deaerator storage space mixed with water coming down from the heating section.

After the load reduction, storage-tank temperature is a few degrees above feed-pump temperature. Part of this difference comes about because storage temperature was measured near the bottom of the tank, under an additional 8-ft static head. The remaining discrepancy must be accounted for by the fact that this was not precision testing—a slight lack of correlation between readings can be expected in this type of field testing.

Period of potential danger to the boiler-feed pump extends throughout the time that the temperature at feed-pump suction is higher than the storage-tank temperature. Should load suddenly be reduced during this period, a substantial drop in deaerator pressure would have to take place before flashing of the stored feedwater could contribute its cushioning effect and reduce the rate of pressure decay.

Relationship between vapor pressures of the stored feedwater and of the water entering the feed pump is the measure of operating danger. Difference between these two pressures represents the margin that would have to be added to required npsh to avoid flashing. At Lieberman No. 4, the worst condition occurs four hours after startup—and so a margin of about 79 ft would be necessary. But even more disturbing is the fact that 75 min after the unit reached full capability, a 35-ft difference still existed. Fortunately, at Lieberman Units 3 and 4 an excess of about 50 ft has been provided over required

provided test data for startup, steady maximum load, shutdown

npsh at full load. But this is exceptional; few installations have so much safety margin. And even with the 50-ft margin, the tests showed that potential danger to the pumps on Unit 4 had not passed until 60 min after the plant had reached full load.

How rapid a pressure-decay rate would have existed, had the unit tripped out during the danger period? At this time no tests have been run, but we hope that additional testing will establish accurate data on this phase of the problem. This plant is not equipped with any controls to protect the pumps against too rapid a rate of pressure decay, prompting the decision to postpone this portion of the investigation.

Since the assumption of an instantaneous pressure decay may be too pessimistic, let us instead carry out a heat balance for the deaerator, assuming that after a tripout, flow of condensate into the deaerator and flow of feedwater out remain constant for a significant period of time. (Most available test data indicates that this is generally the case for as long as 15 sec. In some cases, as a matter of fact, shrinkage in the boiler drum causes an increase in the feedwater flow.) On this basis the condensing effect of flow into the deaerator will be sufficient to reduce deaerator pressure by an amount equal to the difference between the vapor pressures at the pump suction and in the storage space within a period of 17 sec. Since residence time for feedwater in the suction piping at maximum load is all of 36 seconds, danger of flashing is still there.

The test story at unbaffled Lieberman No. 3 is anticlimactic. All that remained was to determine whether any significant differences existed between feed-pump temperature and deaerator storage-tank temperature. As you can readily see, it is almost impossible to distinguish between these two temperatures. There is no indication of any stagnation effect in the storage tank of this deaerator, with no antiflash baffling. Here again, a tripout test would provide interesting data regarding the rate of pressure decay. We hope that such a test can be carried out.

As a result of these tests, Southwestern Electric Power Co has decided to remove the baffling from the storage shell at Lieberman No. 4. For the same reasons, a new deaerator to be installed in Unit No. 1 of their Wilkes Station will have no baffling.

We feel these tests have shown that the undesirable effects of antiflash baffling are just as real in the U.S. as they are in the Japanese installations. Tests conducted at Lieberman represent normal operation, rather than the severe startup conditions imposed during the commissioning of new Japanese power plants. While our domestic installations possibly trip out less frequently than elsewhere, *tripouts do occur*. No operating engineer will knowingly accept these hazards.

As a matter of fact, sudden load reduction need not take place shortly after a cold startup for antiflash baffling to introduce a real hazard. Any unit operating over a wide range of loads will be in danger. For example, if a unit has operated at low loads for some time, deaerator storage will be at a temperature corresponding to the low loads. If load increases rapidly and then drops suddenly, the storage water will not have had time to come up to full saturation temperature. Subcooling may be less extensive than if the sudden load drop were to follow a cold startup, but it could cause trouble.

Perhaps many more tests should be run on many more deaerators before a final verdict is handed down. We do not dispute the value of accumulating as much additional evidence as possible. On the contrary, we find it rather strange that engineers have engaged in so *much* controversial discussion on this subject and yet have done so *little* test work. But we believe that from here on, controversy will confine itself to the degree of subcooling, with its existence accepted as fact. We therefore recommend the elimination of any baffling which guides feedwater from the deaerating element directly to the storage-tank outlet.

Want more background material on antiflash baffling?

ASME Transactions, Jan 1946, "Certain aspects of high-pressure centrifugal pumping," I J Karassik

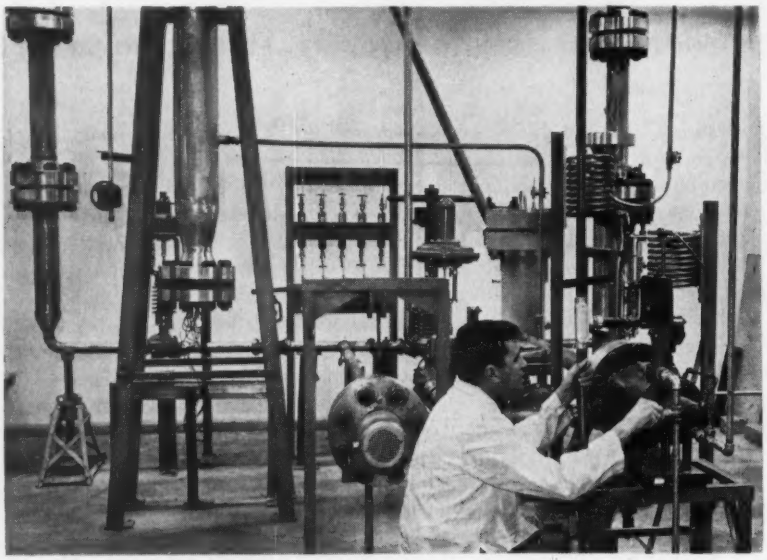
Proceedings, American Power Conference, Vol XIV, 1952, "Effect of sudden load changes on centrifugal boiler-feed pumps," I J Karassik, G H Bosworth, B J Schmid

ASME paper 53-F-2, 1953, "Centrifugal boiler-feed pumps under transient operating conditions," I J Karassik, G H Bosworth, W D Elston

The International Operating Engineer, July 1957 through Jan 1958, "Sudden load drop in open feed cycles of steam-turbine power plants," I J Karassik, G H Bosworth and W D Elston

Combustion: May 1959, "Steam power plant clinic," I J Karassik; Nov 1959, "More about antiflash baffling," I J Karassik, L E Zabel and E K Hess; Feb 1960, "Protecting boiler-feed pumps against flashing," P H Hardie and "Comments" by I J Karassik and L E Zabel; July 1960, "Comments" by R M Lemen, "Answer" by I J Karassik

One of newer reactor ideas uses a canned pump to circulate water which serves as both moderator and coolant. New reactor eliminates control rods and uses uranium fuel in small pellet form for easy manufacture and refueling. To prove out the design . . .



HIGH-TEMPERATURE ABRASION-TEST LOOP provides data on nuclear-fuel pellets used in new Liquid Fluidized Bed Reactor currently being developed by The Martin Co

Zero-leakage canned pump powers test loop

Nuclear reactors demand a high degree of purity in their materials and complete containment of their fluids. Zero-leakage canned-motor pumps help to meet this need. In atomic test loops, used for study and evaluation of reactor components and systems before their adoption in the full-scale plant, high temperatures and pressures make zero-leakage pumps a must.

Nuclear Division of the Martin Company now has a Liquid Fluidized Bed Reactor (LFBR) under study. The reactor uses a slightly enriched uranium in the form of pellets about ¼-in. dia, either bare or coated with a metal like nickel or zirconium.

Fuel pellets are inside an upright cylinder with a fluid inlet at the bottom and outlet at top. When there's no fluid flowing, the pellets rest on a perforated plate at the cylinder bottom as shown in the sketch, facing page, upper right. Fluid acts as both moderator and coolant. In this position there is not enough fluid between the pellets to sustain a chain reaction. With insufficient moderator between fuel elements the random neutrons ejected by the uranium are not slowed enough to be absorbed by the U-235 atoms and so they escape to the surroundings.

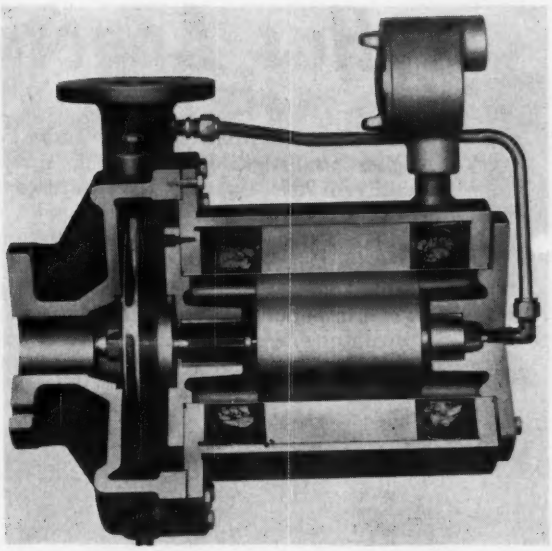
When fluid is pumped upward through the plate supporting the fuel pellets, it forces them to separate and dance in random positions. As the pellets move apart, enough moderating fluid passes between them to slow down the neutrons so that they will support a chain reaction. Fissioning U-235 heats the pellets and in turn the fluid, which carries off the heat to its point of use in the reactor circuit. Varying fluid flow controls rate of fissioning, just as control rods do. Preliminary studies by Martin show a reasonably wide range of operation that still maintains efficient reaction.

Potential advantage of the LFBR lies in completely eliminating control rods and the complicated mechanism needed to move them. Power can be turned on and off by adjusting the flow rate of the moderator-coolant fluid. The fuel pellets seem easier to fabricate, install and remove than most fuel elements now used. In addition, some pellets could be replaced on a continuous-refueling basis, which would eliminate downtime needed to replace cores in today's reactor models.

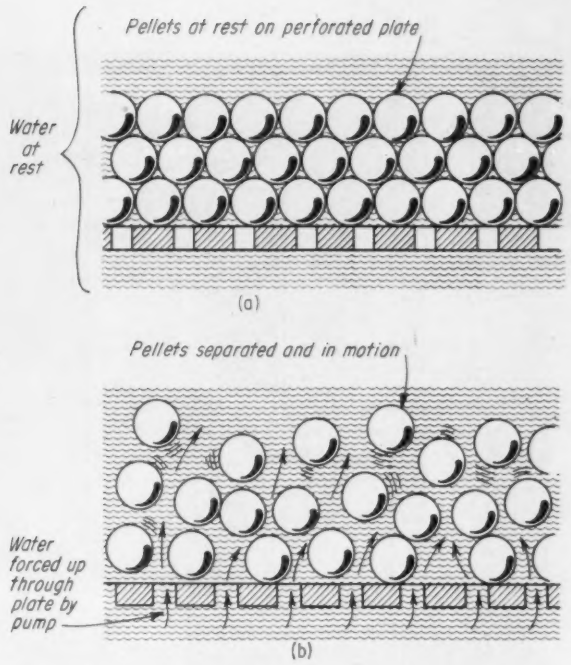
Studies show that fuel pellets would burn up uniformly. Since there is no structural material inside the core to absorb neutrons, the conversion of U-238 into plutonium is expected to be higher. This could lead to higher burnup.

Large area of contact between the thousands of pellets and the moderator-coolant liquid greatly aids heat transfer. The LFBR has a built-in safety factor against loss of flow—this would immediately halt the chain reaction and release of heat.

Canned pump must be used with the LFBR to handle the hot radioactive fluid. Martin has chosen a Chempump combined motor and pump hermetically sealed in a single unit, cross section above. Rotor, shaft



ROTOR, SHAFT AND IMPELLER of Chempump canned pump form a single rotating assembly. Cylinders enclose rotor and stator



URANIUM PELLETS AT REST, (*a*), do not maintain chain reaction. In (*b*), more moderator between pellets sets up reaction

By R G CARPENTER, Chief Engineer
Chempump Div, Fostoria Corporation

and impeller form a single rotating assembly immersed in the pumped fluid. A small part of the fluid flows between rotor and stator of the motor for both cooling and bearing lubrication. Corrosion-resistant non-magnetic-alloy cylinders completely enclose the rotor and stator. In this design there are no stuffing boxes and therefore no possible leakage.

Abrasion study has a canned pump at work moving the fluid through a high-temperature high-pressure test loop. The 15-hp pump with 7.5-in. impeller circulates demineralized water at 600 F and 2000 psig.

It is expected that the loop will yield data on fuel-pellet abrasion resistance, fabrication problems and costs. Martin has under study these methods of cladding the pellets for corrosion and abrasion resistance:

(1) Plating pure metals on the surface

(2) Vapor-depositing pure metals

(3) Hot coining and bonding of alloys or pure metals in wrought form

(4) Hot hydrostatic pressing of pellets encased in cladding materials

(5) Combinations of the four.

These techniques are being studied to develop an abrasion-resistant uranium-dioxide pellet:

(1) Adding materials to increase strength and improve bonding of the particles in sintered UO_2 pellets

(2) Applying abrasion-resistant coatings to sintered UO_2 pellets

(3) Combining (1) and (2) to develop optimum conditions for reducing wear by abrasion.

The high-pressure abrasion loop has two test sections in parallel channels. Flow rates and fluid velocities are equal. Each section has 24-in. lengths of 5-in. nominal-dia pipe, flanged for easy removal.

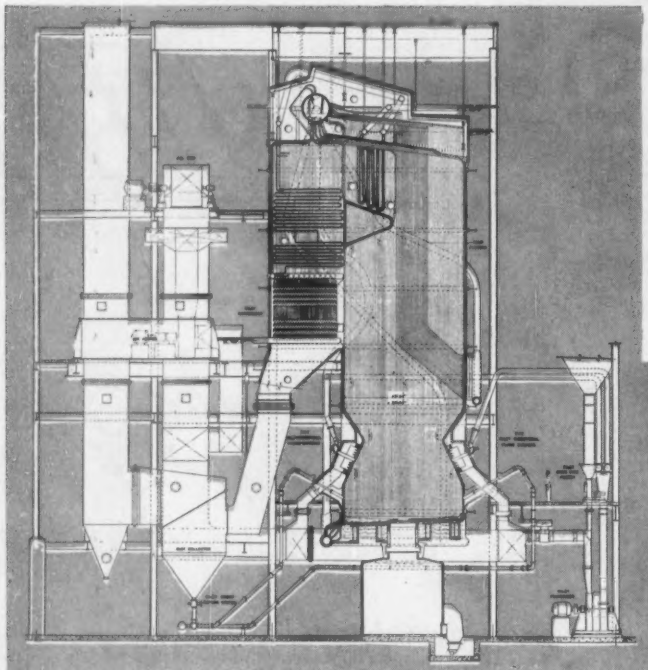
For independent operation each section has one *in* and one *out* shut-off valve, an automatic flow-control valve with pickup orifice, differential-pressure cell and flow recorder. An automatic flow-control valve operating on a signal from the in-line flow indicator regulates fluid velocity through each test section. A sample vent valve is in the loop line upstream and downstream of the combined test sections.

A filter in the loop removes abrasive particles larger than 25 microns to minimize damage to pump, valves and other components. A pressurizer, liquid-level indicator and pressure indicator keep constant pressure in the loop by running charging pump and pressurizer heater automatically.

A 30-kw heater maintains operating temperature in the loop. A charging loop, consisting of demineralized-water storage tank and reciprocating charging pump, feeds makeup water upstream of the heater.

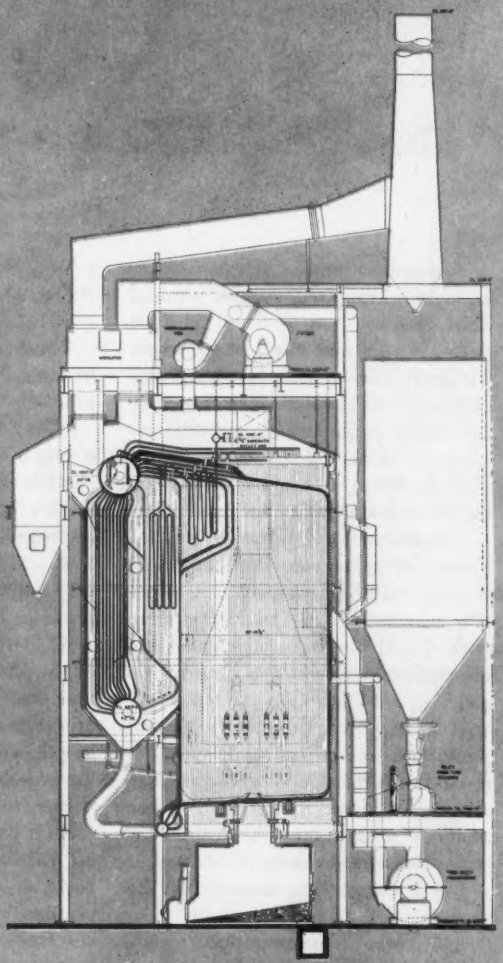
Other problems under study include: methods of removing soluble and insoluble abrasion and fission products from the primary coolant, stability of the LFBR system and methods of control for full-scale systems. Many problems must still be solved, but Martin hopes to prove out the LFBR conception as the practical form of a working reactor.

RILEY TURBO FURNACE ...Has Appetite



These four industrial type Riley Turbo Furnace Boiler installations demonstrate the exceptional ability of this exclusive Riley furnace design to utilize a wide variety of fuels.

The Turbo Furnace design efficiently utilizes waterwall surfaces producing rapid and uniform natural water and steam circulation. Uniform gas distribution produces minimum variation in superheater temperatures. Absence of excessive wall deposits reduces need for wall blowers.



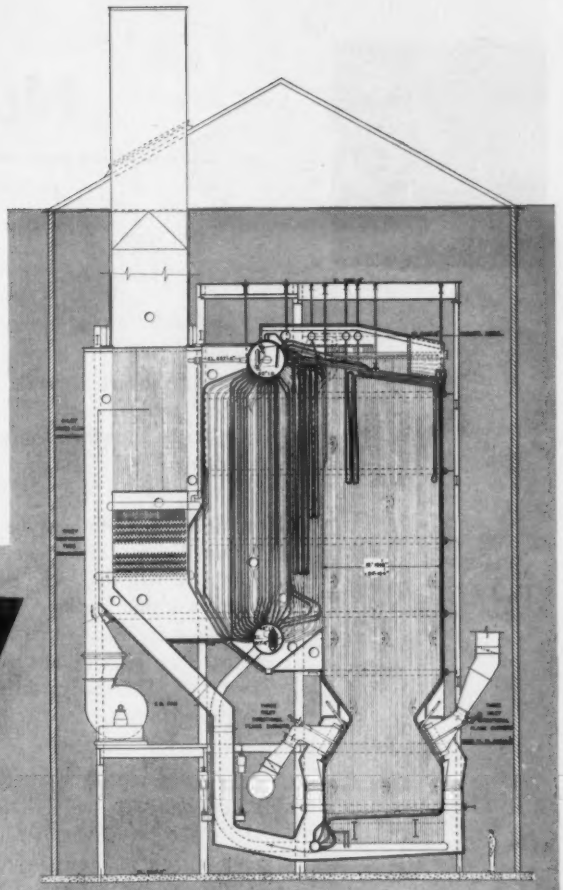
PULVERIZED COAL

These two Riley Turbo Furnace Boilers for two large chemical companies each will fire coal pulverized by Riley 550 Pulverizers. The 650,000 lb/hr Turbo Furnace unit (above) is designed for a pressure of 1400 psig and a steam temperature of 900 F. Coal is pulverized by five Riley 550 pulverizers. Operating efficiency is 89.2%. The Turbo Furnace Boiler at right is designed with a steam capacity of 150,000 lb/hr at a pressure of 700 psig and a temperature of 760 F. Fired by two Riley 550 Pulverizers.

for Many Fuels

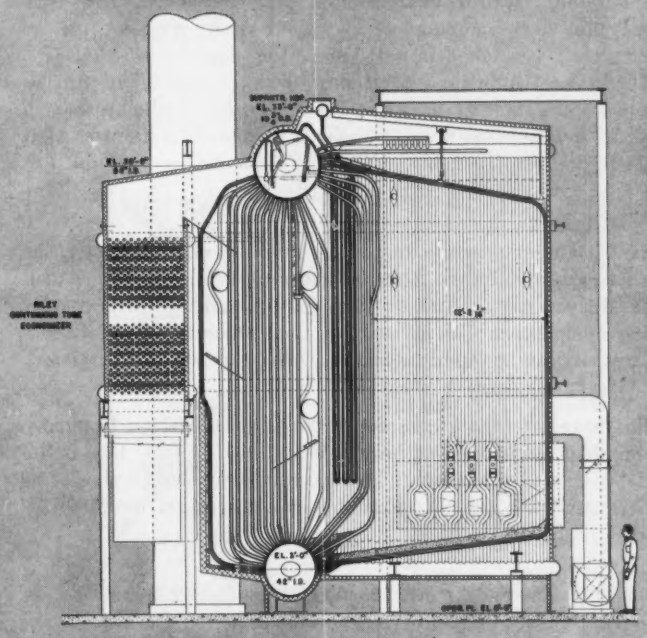
Carbon loss and flyash are kept to a minimum. Steam temperatures are maintained over a wide load range. Burners on one level make supervision easy and automatic operation convenient.

For further details about the unusual fuel burning capability of the Riley Turbo Furnace call your Riley representative or write direct to RILEY STOKER CORPORATION, Worcester, Massachusetts.



BLAST FURNACE GAS, OIL

A prominent steel producer is using this 350,000 lb/hr Riley Turbo Furnace boiler to burn blast furnace gas and oil. The unit is designed for a pressure of 975 psig with a steam temperature of 850 F and at an efficiency rating of 78.5%. The furnace is also pressurized.



CO GAS, GAS AND FUTURE OIL

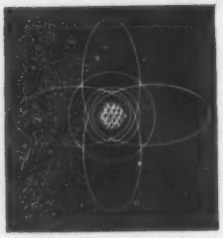
Riley Turbo Furnace boiler unit for a Texas refinery will fire natural gas at 75,000 lbs/hr and at 50,000 lbs/hr capacity will fire catalytic flue gases which will help to reduce atmospheric pollution. The unit is designed for 450 psig and 650 F.

For Complete Details About Riley Boilers Write RILEY STOKER CORPORATION, WORCESTER, MASSACHUSETTS

Sales Offices: Boston, Charlotte, Chicago, Cincinnati, Cleveland, Denver, Detroit, Honolulu, Jacksonville, Kansas City, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Salt Lake City, San Francisco, St. Louis, St. Paul, Seattle, Syracuse.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT



Nuclear notes

By B G A SKROTZKI, Associate Editor

Yankee Atomic Plant at Rowe, Mass. will have a final installed cost about $13 million below original estimates of $57 million. Up to the end of June 1961 the plant has generated over 400-million-kwhr output. Plant construction has run about 6 to 8 weeks ahead of schedule.

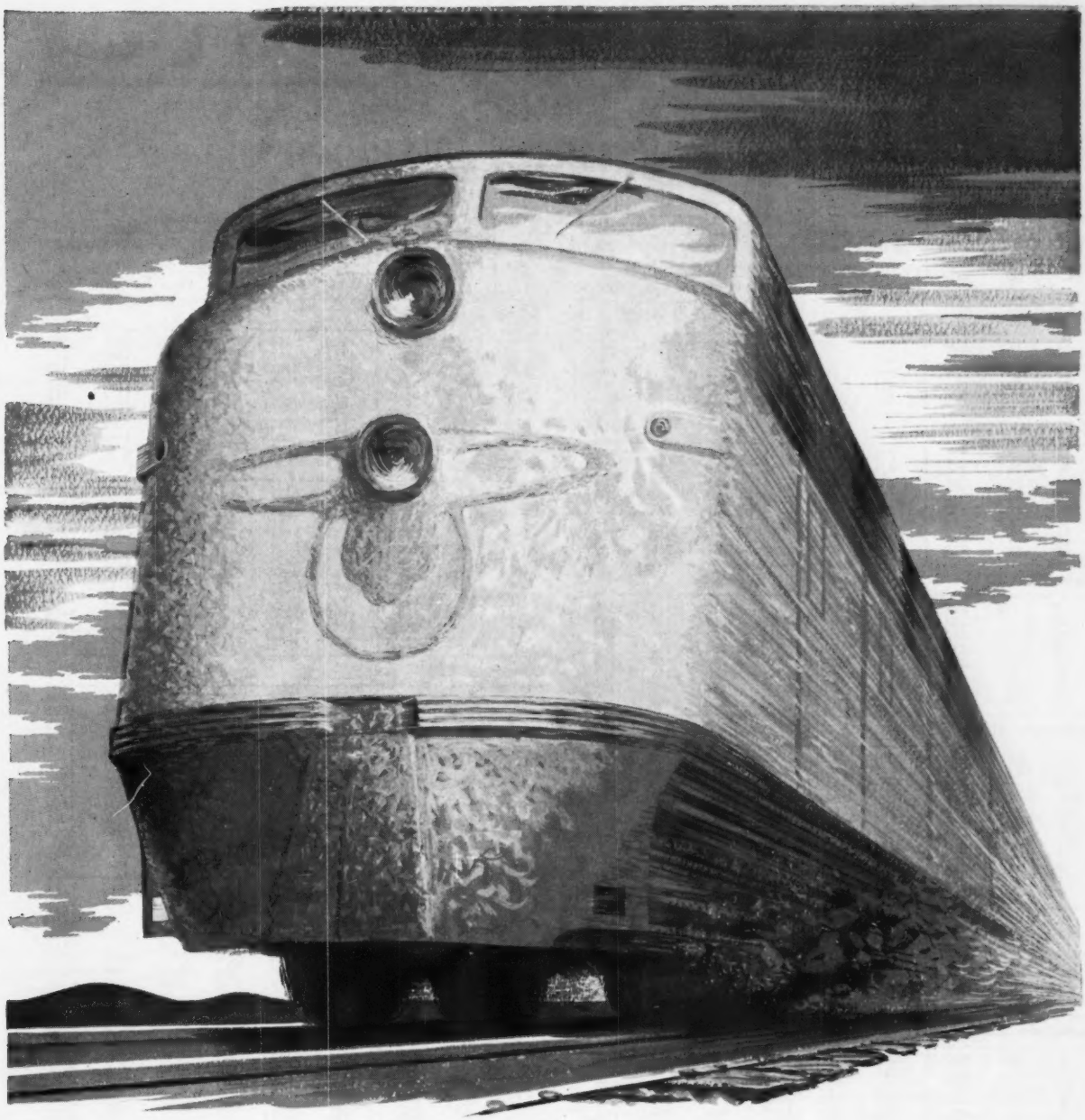
Nuclear plant in India may be decided by a joint study to be made by Canada and India. Atomic Energy of Canada Ltd, assisted by staff from the Montreal Engineering Company Ltd, will make the study with the Indian AEC. The plant would be similar to Douglas Point Nuclear Power Station now building near Port Elgin, Ont. Latter 200-mwe-capacity plant starts in 1965 and will use natural uranium and heavy-water moderator. The Indian plant will be in the general area of East Punjab, Delhi, Rajasthan, West U.P. The study will take about six months; India will decide after costs have been determined.

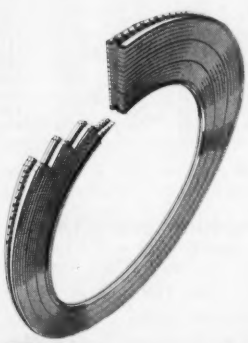
First automatic weather station went into operation in the Canadian Arctic last month. Built by the Martin Company for the USAEC, the unit uses decaying strontium-titanate pellets (about one lb of them) to fuel the radio-transmission system. The plant is placed on Graham Island near Norwegian Bay, standing between manned weather stations at Eureka and Resolute. Heat from the isotope pellets is converted to electricity by 60 pairs of lead-telluride thermocouples. The plant is expected to run for two years (the strontium should be good for ten) generating four watts to trickle-charge the 28-v nickel-cadmium batteries. Excess heat from isotope decay will be used to hold station's interior temperature at 70 F. The station will radio its anemometer, temperature and barometric measurements every three hours to stations at Alert and Resolute. The Canadian ice breaker *CMS John A MacDonald* carried the 8-ft station to its site.

Gas industry expects results from atomic-energy research, according to the Rochester Gas and Electric Corp as told at a recent Public Service Commission hearing. They look for breakthroughs in the area of gas production from coal in the next two years and hope to make the process competitive with natural gas. Coal which is completely gasified at mines by atomic reactors can be piped to market. (*McGraw-Hill World News*)

Netherland's electric utilities have awarded a contract to the General Electric Company to do a design study with them on a 50-mwe boiling-water-reactor plant. This is the fourth European plant for GE; the others are: (1) a recently completed 15-mwe plant near Frankfurt, West Germany (2) 150-mwe plant under construction in Italy (3) 12.5-mwe plant just started in Japan.

Nuclear Ship Savannah has been authorized by AEC to fuel, start up and operate its reactor for test and demonstration at Camden, N.J., Yorktown, Va. and at sea. Phase I covers tests of construction, machinery installation, components, wiring and piping; Phase II covers testing reactor system in place without fuel; Phase III covers loading fuel elements at Camden, N.J.; Phase IV covers running reactor up to 10% rating at Camden, then transfer of ship with reactor shut down to Yorktown, where reactor will be run up to capacity; Phase V covers sea trials of vessel with Yorktown as the operating base. Extended sea trials will be conducted later by States Marine Lines, Inc as general agent of the Maritime Administration.





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Flexitallic Gasket Company, Camden 2, New Jersey. Stocking Distributors for Standard Flexitallic Gaskets in principal cities.

For more facts circle 251 on Reader Service card, p 109

Power's data sheet

No. 349

Alloy-steel pipe to ASTM Spec A-335 Grade P-12 (1% Cr – ½% moly)

Pipe size, in.	Nom OD, in.	Wall thick, in.	Temperature, F: To 750	800	850	900	950	1000
			Maximum allowable stress, psi: 15,000	14,750	14,200	13,100	11,000	7500
Schedule 10								
14	14	.250	475	467	450	415	350	240
16	16	.250	415	408	393	363	305	209
18	18	.250	369	362	349	322	271	186
20	20	.250	331	326	314	289	244	167
24	24	.250	276	271	261	241	203	139
Schedule 20								
8	8.625	.250	777	764	736	679	573	395
10	10.75	.250	621	611	588	543	458	315
12	12.75	.250	522	514	495	456	384	264
14	14	.312	594	584	563	519	438	301
16	16	.312	519	510	491	453	382	262
18	18	.312	461	453	436	402	339	232
20	20	.375	499	490	472	435	367	352
24	24	.375	415	408	392	362	305	209
Schedule 30								
8	8.625	.277	861	847	815	752	635	438
10	10.75	.307	766	753	725	669	565	389
12	12.75	.330	693	681	656	605	510	351
14	14	.375	716	704	678	626	528	363
16	16	.375	625	615	592	546	460	317
18	18	.438	649	639	615	567	478	329
20	20	.500	669	658	633	584	493	339
24	24	.562	625	615	592	546	460	317
Schedule 40								
⅛	.84	.109	1103	1085	1044	963	815	564
¼	1.05	.113	997	981	944	871	736	509
⅜	1.315	.133	1200	1180	1136	1048	887	615
1¼	1.66	.14	1078	1060	1021	942	797	551
1½	1.90	.145	1005	988	952	878	742	513
2	2.375	.154	905	890	857	791	668	461
2½	2.875	.203	1217	1197	1152	1063	900	624
3	3.50	.216	1094	1076	1036	955	808	559
4	4.50	.237	1433	1409	1356	1251	1061	737
5	5.563	.258	1259	1238	1192	1100	931	646
6	6.625	.28	1143	1124	1082	998	845	585
8	8.625	.322	1007	990	953	880	744	514
10	10.75	.365	912	897	863	796	673	464
12	12.75	.406	854	840	809	746	630	435
14	14	.438	839	825	794	733	619	427
16	16	.50	840	826	795	733	619	427
18	18	.562	838	824	794	732	618	426
20	20	.593	797	783	754	696	587	405
24	24	.687	768	755	727	671	566	390
Schedule 60								
8	8.625	.406	1277	1255	1209	1115	944	655
10	10.75	.50	1263	1242	1196	1103	934	648
12	12.75	.562	1195	1175	1131	1043	883	612
14	14	.593	1148	1129	1087	1003	849	588
16	16	.656	1108	1090	1049	968	819	567
18	18	.750	1126	1107	1066	983	832	576
20	20	.812	1098	1079	1039	959	811	561
24	24	.968	1091	1073	1033	953	806	558
Schedule 80								
⅛	.84	.147	2434	2393	2304	2126	1814	1279
¼	1.05	.154	2113	2077	2000	1845	1571	1103
⅜	1.315	.179	2222	2092	2103	1940	1654	1162
1¼	1.66	.191	1939	1907	1835	1693	1440	1008
1½	1.90	.20	1821	1791	1724	1591	1352	945
2	2.375	.218	1661	1634	1573	1451	1232	859
2½	2.875	.276	1942	1910	1838	1676	1443	1010
3	3.50	.30	1778	1748	1683	1553	1319	922
4	4.50	.337	2076	2041	1965	1813	1543	1083
5	5.563	.375	1856	1825	1757	1621	1378	964
6	6.625	.432	1793	1763	1698	1566	1331	930
8	8.625	.50	1588	1561	1503	1387	1177	820
10	10.75	.593	1510	1484	1429	1318	1118	778
12	12.75	.687	1416	1447	1394	1286	1090	758
14	14	.75	1460	1436	1383	1275	1082	752
16	16	.843	1439	1415	1362	1257	1065	741
18	18	.937	1420	1397	1344	1240	1051	731
20	20	1.031	1404	1380	1329	1226	1039	722
24	24	1.218	1383	1360	1309	1208	1024	711

Pipe size, in.	Nom OD, in.	Wall thick, in.	Temperature, F: To 750	800	850	900	950	1000
			Maximum allowable stress, psi: 15,000	14,750	14,200	13,100	11,000	7500
Schedule 100								
8	8.625	.593	1900	1869	1799	1659	1411	988
10	10.75	.718	1842	1811	1743	1608	1367	956
12	12.75	.843	1823	1793	1726		1354	946
14	14	.937	1846	1815	1747	1612	1371	958
16	16	1.031	1771	1742	1677	1547	1314	918
18	18	1.156	1766	1737	1672	1542	1311	915
20	20	1.281	1760	1731	1666	1537	1306	912
24	24	1.531	1753	1724	1660	1531	1301	909
XX								
½	.84	.294	8389	8249	7942	7327	6517	5040
¾	1.05	.308	6941	6826	6571	6062	5337	4030
1	1.315	.358	6658	6547	6303	5814	5109	3840
1¼	1.66	.382	5585	5491	5287	4877	4254	3143
1½	1.90	.400	5114	5029	4841	4466	3883	2848
2	2.375	.436	4480	4406	4241	3913	3387	2461
2½	2.875	.552	4934	4852	4671	4309	3741	2737
3	3.50	.600	4407	4333	4172	3848	3329	2416
4	4.50	.674	4394	4320	4159	3837	3319	2408
5	5.563	.750	3905	3840	3697	3411	2940	2118
6	6.625	.864	3767	3704	3566	3290	2834	2037
8	8.625	.875	2868	2820	2715	2504	2144	1521
Schedule 120								
4	4.50	.438	2740	2694	2594	2393	2047	1449
5	5.563	.50	2520	2478	2386	2201	1880	1327
6	6.625	.562	2368	2329	2242	2066	1765	1243
8	8.625	.718	2323	2284	2199	2029	1730	1218
10	10.75	.843	2182	2146	2066	1906	1624	1141
12	12.75	1.00	2178	2142	2062	1902	1621	1139
14	14	1.093	2169	2133	2054	1894	1614	1134
16	16	1.218	2113	2078	2001	1846	1572	1103
18	18	1.375	2118	2083	2005	1850	1576	1106
20	20	1.50	2079	2044	1968	1815	1546	1084
24	24	1.812	2093	2058	1982	1828	1557	1092
Schedule 140								
8	8.625	.812	2467	2603	2506	2312	1976	1398
10	10.75	1.00	2612	2568	2473	2281	1949	1378
12	12.75	1.125	2468	2426	2336	2155	1840	1298
14	14	1.25	2500	2459	2367	2184	1865	1316
16	16	1.437	2517	2475	2383	2198	1877	1325
18	18	1.562	2426	2385	2296	2118	1808	1275
20	20	1.75	2446	2405	2316	2136	1824	1286
24	24	2.062	2399	2359	2271	2095	1788	1260
Schedule 160								
½	.84	.187	3947	3882	3737	3447	2973	2143
¾	1.05	.218	4017	3950	3803	3508	3027	2184
1	1.315	.25	3873	3808	3666	3382	2915	2099
1¼	1.66	.25	3006	2956	2846	2625	2249	1599
1½	1.90	.281	3093	3042	2928	2702	2316	1649
2	2.375	.343	3237	3183	3064	2827	2426	1731
2½	2.875	.375	2960	2910	2802	2585	2214	1573
3	3.50	.438	2939	2890	2783	2567	2199	1562
4	4.50	.531	3379	3323	3199	2951	2535	1812
5	5.563	.625	3201	3148	3030	2796	2399	1710
6	6.625	.718	3082	3031	2918	2692	2308	1642
8	8.625	.906	2977	2927	2818	2600	2227	1583
10	10.75	1.125	2908	2860	2753	2540	2175	1544
12	12.75	1.312	2911	2862	2756	2542	2177	1545
14	14	1.406	2835	2788	2684	2476	2119	1503
16	16	1.593	2812	2765	2662	2455	2101	1490
18	18	1.781	2790	2743	2641	2436	2085	1477
20	20	1.968	2776	2729	2628	2424	2074	1469
24	24	2.343	2752	2706	2605	2403	2056	1456

Maximum allowable working pressure—4

Figures in table are maximum pressures, psi, for given temperatures and stresses. See June *Data Sheet 346* for basic formula used to calculate the table.

GEORGE C HALZELL, *Boston, Mass.*

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(Advertisement)

What Really Happens Inside the Bucket

Exploding a widespread misconception of the operation of inverted bucket steam traps

In describing the operation of the inverted bucket trap many well meaning people—and some not so well meaning; i.e., competitors—refer to the need for a "bucket full of steam" to close the trap, and a "bucket full of condensate" to open the trap. The implications of these requirements are many. Sometimes they are contradictory. Often they are misleading. Observations of a trap with a glass body and a glass bucket plus trap design considerations tell the true story.

* * *

In a well designed inverted bucket trap (Armstrong, naturally) the bucket will float and close the valve when it is *no more than two-thirds full of steam.* For example, the bucket in an Armstrong No. 812 trap is $3^{15}/_{16}$" deep. It will float with only 2" of steam.

Good design also dictates that the maximum test opening pressure of a trap should be well in excess of the maximum working pressure for which the trap is furnished. For example a No. 812 trap for 100 psi with the bucket filled with cold water should open at a test pressure of at least 165 psi. Therefore, the bucket does not have to fill completely with condensate to open at 100 psi. The entrance of 1.20" of condensate will cause the bucket to sink. .8" of steam remains at the top of the bucket at the time it is heavy enough to open the valve at 100 psig and with no back pressure.

Thus the opening and closing of a 100 psi trap with $3^{15}/_{16}$" deep bucket is controlled by a change in the water level of only 1.20".

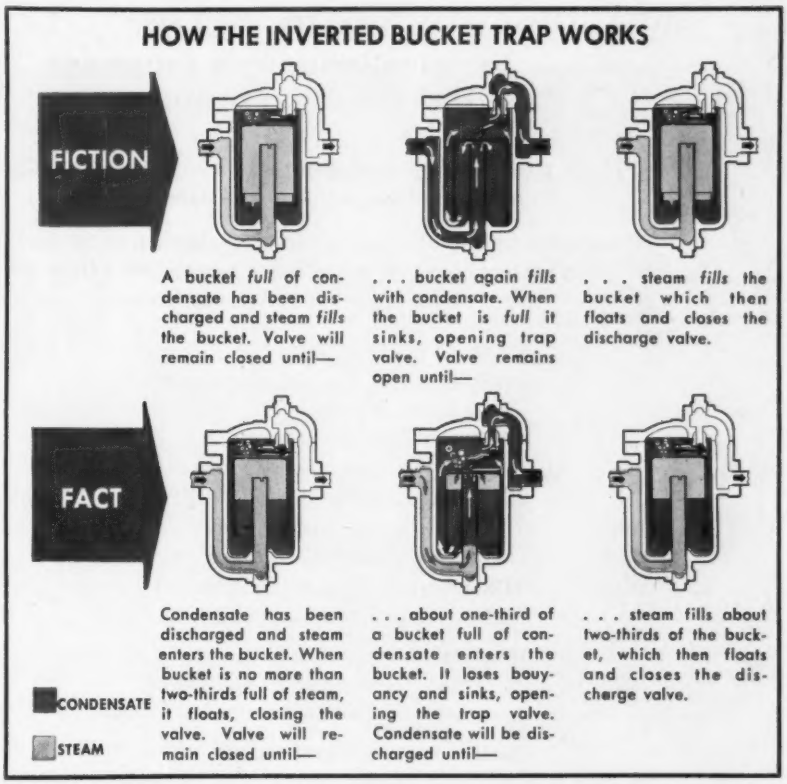
In actual practice the 100 psi trap may be draining a steam main in which daytime pressure is only 30 psig. Instead of requiring a 1.20" rise in bucket water level to open the trap against this pressure, the bucket will be heavy enough to open the valve as soon as the water level in the bucket has risen about $^3/_{16}$".

Obviously, it does not "take a bucket full of steam" to close the inverted bucket trap, or a "bucket full of condensate" to open the trap.

What's the Significance?

As illustrated above the opening of an Armstrong Trap requires the accumulation in the trap of less than one-third of a bucket full of condensate. This assures good operating characteristics for the vast majority of services by discharging small accumulations of condensate as soon as they reach the trap. It also assures frequent opening pressure drops to break up air and condensate films on heat transfer surfaces and thereby maintain high heat transfer rates in the unit being drained.

Additionally, the fact that no more than two-thirds of a bucket of steam is required to float the bucket means that there will always be a generous water seal at the bottom of the bucket. In the case of the No. 812 trap described above, it will be 1.8" deep. This insures that no steam can leak from the bottom of the bucket. More importantly, the bucket can float to close the valve even when the bucket is not completely submerged in condensate.


HOW THE INVERTED BUCKET TRAP WORKS
FICTION
A bucket full of condensate has been discharged and steam fills the bucket. Valve will remain closed until—
. . . bucket again fills with condensate. When the bucket is full it sinks, opening trap valve. Valve remains open until—
. . . steam fills the bucket which then floats and closes the discharge valve.
FACT
Condensate has been discharged and steam enters the bucket. When bucket is no more than two-thirds full of steam, it floats, closing the valve. Valve will remain closed until—
. . . about one-third of a bucket full of condensate enters the bucket. It loses buoyancy and sinks, opening the trap valve. Condensate will be discharged until—
. . . steam fills about two-thirds of the bucket, which then floats and closes the discharge valve.
CONDENSATE
STEAM

A Proven Principle Engineered Up to the Minute

While the inverted bucket concept for steam traps is half a century old, today's Armstrong inverted bucket traps incorporate design considerations unknown 50 years ago. The inverted bucket of the Armstrong trap, for example, is not just an upside down bucket. It is a carefully sized, weighted and vented component of a steam trap mechanism that experience proves will do its job right. Throughout, Armstrong design has kept pace with technological advancements, modified when necessary to meet changing requirements.

We do not claim that Armstrong Traps will do every single job better than any other trap. But we do believe it will do more jobs better and more consistently than any other trap. More important, though, for most services, Armstrong Inverted Bucket Steam Traps enable you to get more efficient steam utilization with minimum problems.

We're so sure of what Armstrong Traps can do that we unconditionally guarantee that they will satisfy you. You are the sole judge, too, so there's practically no risk.

* * *

The 48 page Armstrong Steam Trap Book describes other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write: **Armstrong Machine Works, 8122 Maple Street, Three Rivers, Michigan.**

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PAPER—Sodium salts recovery
CHEMICAL—Aerosol and acid mist collection
METALLURGICAL—Metallic dusts and fumes collection
CEMENT—Kiln and finish mill dust collection
GYPSUM—Kettle, mill and dryer dust collection
PETRO-CHEMICAL—Catalyst recovery
RUBBER—Carbon black collection

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These low first cost high efficiency collectors provide greater separating forces and reduction in over-all resistance (pressure drop) than other types of mechanical collectors. They are available in multiple tube and involute designs.

Combination Electrostatic-Mechanical Collectors
Under some conditions the most economical solution to a gas cleaning problem is a combination of the Cyclo-trell ahead of or after a Research-Cottrell Precipitator.

Electrostatic Air Cleaners
Custom air cleaners such as those Research-Cottrell developed for the Navy's nuclear submarines are available for special applications.

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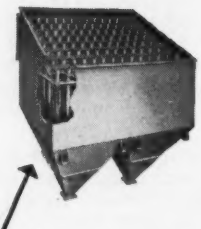
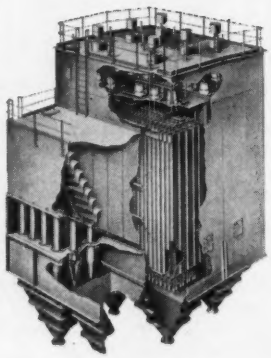
Adjustable—High efficiency. No increase in pressure drop, even at gas flows 50% over normal. No nozzles to wear or plug up.





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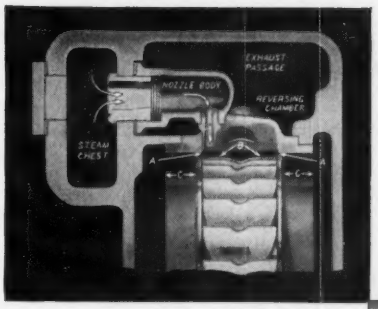
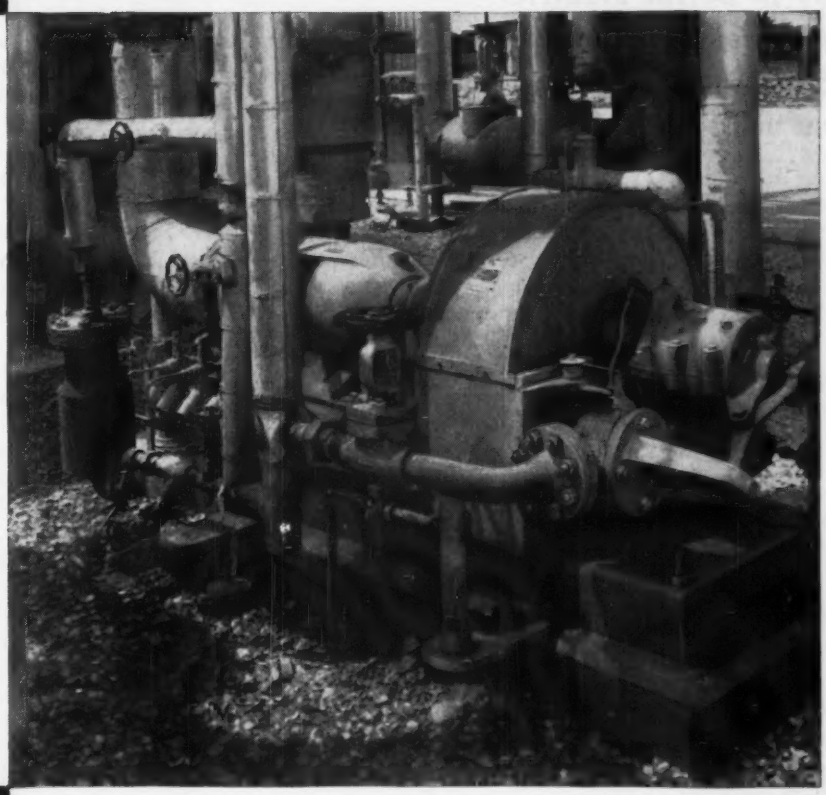


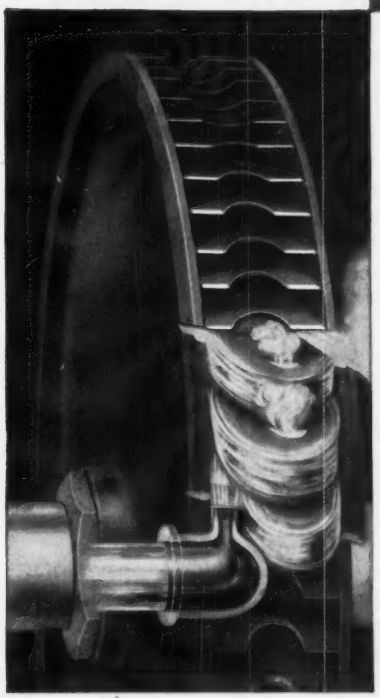
TWO REASONS WHY

this turbine seldom sees down time



1 ***Generous wheel clearances:*** AA —rim clearance, B—blade clearance, CC —side clearance. Blades can't foul as they are protected by rims. Rubbing at AA will do no damage. Side clearance is so large (about one inch) that end-play from excessive external thrust cannot damage wheel.

2 ***Blade wear is of little consequence.*** In a Terry solid-wheel turbine, the steam enters the buckets at right angles to the shaft. As its power-producing action takes place on the curved surfaces at the backs of the buckets, wear does not materially affect horsepower or efficiency.



To prevent costly shutdowns for repairs, Terry builds bonus reliability into each solid-wheel turbine. Two of the ways in which this is accomplished are shown in the diagrams at the left.

Further details of these simple, fool-proof turbines are illustrated and described in bulletin S-116. If you do not already have a copy of this publication, send for one today. No cost or obligation.

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TERRY

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Technical briefs . . . A world-wide look at

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Key to better electric-power service: active coordination between industry and utility—early in the game!

What the industrialist should know and do when arranging to obtain utility power, *W E Marter, Duquesne Light Co and A Hauspurg, American Electric Power Service Corp*
Part I covers relationship between customer's relay-protection design and the relay protection installed on the utility system. They must be carefully coordinated early in the game to work best.

Part II describes power-system performance and its effect on several common items of industrial equipment — induction and synchronous motors, electric process-control equipment.

To show system effect on utility performance, several types of system feed are described. Fault effect in each is detailed.

Paper includes several prepared discussions. *AIEE CP 61-829*

Teamwork, the key to electrical-service continuity for continuous-process plants, *M M Gilbert, E I du Pont de Nemours & Company*
Efforts to promote mutual understanding between Du Pont process engineers, utilities and equipment manufacturers have paid off in greater continuity of electrical service. Sometimes it's merely variations in definitions of terms that need to be ironed out. For example: utility people may feel there has been no interruption in service, should breakers open to clear a fault and reclose in a few cycles. But to the power user with an automated process, it's usually just as bad that the circuit was dead for 30 cycles as for 30 minutes.

Where process needs have gone beyond the maximum that a utility can afford to provide at the prevailing rate, Du Pont has on occasion rented items, or paid a facilities charge over and above what the utility considers normal supply cost for the size of load involved. Many examples show where unique circuitry or special equipment have met continuous-process needs in Du Pont installations. *AIEE CP 61-799*

Testing protective devices on industrial-plant power systems, *R J Dikeman, R M Shoop, Multi-Amp Electronic Corporation*
Unless electrical protective devices are adequately tested right after installation *and* periodically during their life, you can't be sure that they will operate properly in an emergency. Any protective device has two functions to perform: (1) It protects a specific feeder, branch or piece of equipment from damage or destruction. (2) It also coordinates with other protective devices in the overall system to prevent disturbance or interruption to other circuits or equipment because of failure in its specific branch.

Preventive-maintenance program for protective devices should be made up of these four elements: (1) an overall plan (2) adequate personnel training (3) a definite schedule (4) complete records. This program is discussed as applying to induction relays, low-voltage breakers and motor-overload and lighting-service protection. *AIEE CP 61-821*

A survey of industrial protective-relay practice, *J J O'Connor, Norman Peach,* POWER
The 27 industrial plants covered by this protective-relay-practice survey were chosen as typical of current practice. Survey aims: determine how well industrial relaying responsibilities are being met, how dependable older installations are, what role the utility, consultant, equipment manufacturer and plant engineer play in system design, what maintenance level is typical.

Conclusion: There is a growing vacuum in the area of industrial relay protection, created by two factors: (1) Utilities wish to divorce themselves from customer relay problems. (2) Industrials are unaware of the true role their relays play in keeping production flowing along smoothly.

But who will fill this vacuum? There are three possibilities: (1) Industrials might build up effective maintenance programs including personnel training. (2) Consulting engineers might extend their service to setting up maintenance programs. (3) Independent service organizations might step in where plant size cannot justify a self-contained program. *AIEE CP 61-857 (Single copies of this paper are available without charge from* POWER'S *Reader Service Dept, while supplies hold out.)*

Air-pollution control

Gas-cleaning efficiency requirements for different pollutants, *W C L Hemeon, Hemeon Associates, Pittsburgh, Pa.*
Conflicting units of measurement for various air-pollutant types cloud their relative importance and, in some cases, lead to shotgun control efforts. This paper presents consistent units of measurement for the following specific nuisance pollutants: smoke

progress in energy-systems engineering

and haze, dustfall, incinerator paper ash, metal corrosives, odors.

Each set of units is also internally consistent. Ground-level-concentration units agree with corresponding stack-gas data in terms of concentration and emission rates. *APCA 61-65*

The gas industry and its contribution to air-pollution control, *C G Segeler, American Gas Association*

Natural-gas combustion process is detailed, stressing air pollutants formed. Sulfur as a product of combustion is insignificant, and oxides of nitrogen are far less than many other common fuels produce. To illustrate this, NO_x outputs of common gas appliances are compared with output of automotive engines. Gas for industrial heating and steam production is a similarly low pollutant producer.

As of today, 97% of all gas delivered (excluding the bottled variety) is natural—only 3% is manufactured. And its use is growing. In the last ten years, gas climbed from 17 to 27% of all energy. By 1970, it should grow another 75%. *APCA 61-52*

The behavior of dense stack gases, *F A Bodurtha, E I du Pont de Nemours & Company*

Model tests fill in much-needed data on stack-gas dispersion for heavier-than-air emission. Although more testing is needed to fully cover this field of knowledge, several important results lead to better understanding of gas behavior. Tests covered gas densities of 1.0, 1.17, 1.52, 2.96 and 5.17, compared to 1.0 for air.

Some test results: Dense plumes rise less than air at first, even though momentum of the dense plume is greater—apparently because of decelerating buoyant forces in the initial ascent. Study demonstrated that dense stack gases should discharge vertically upward from a minimum-possible-diameter stack to give maximum velocity for each flow rate. *APCA 61-14*

Automatic control

The installation of automatic controls in an existing power plant for minimum downtime, *J A Reich, Gulf States Utilities; T H Bloodworth, Allis-Chalmers Mfg Co; L M Wilson, Consolidated Systems Corporation*

Automatic control of new base-loaded units usually balances out these five factors: safety, reliability, economy, quick response to abnormal conditions, size and complexity. But two more factors come into the picture when you're considering automatic control to be installed in an older, peak-load unit—personnel transfer and a second safety consideration based on extra risk due to frequent unit startup.

At Gulf States Utilities' Riverside Station, two older and relatively small units are available for system peaking. Their sizes: 35 and 40 mw. Planning installation of automatic control for these two units involved establishing job boundaries, determining equipment modification, setting signal standardization. Then came scheduling to limit unit downtime. Here much of the equipment could be installed while units were running—actual hookup then involved minimum time. *APC*

Electronic combustion control and theory of operation, *J H Warren, Republic Flow Meters Co, P O Box 1181, Atlanta 1, Ga.*

"Plug-in maintenance" of combustion-control equipment is prime consideration of equipment manufacturers today. This means easier troubleshooting, quicker replacement of defective equipment, reliability upped even further.

Miniature compatible solid-state instrumentation together with other solid-state components and miniature panel-mounted control equipment make electronic combustion control even more flexible. Modern systems essentially consist of field-mounted transmitters, valves and final drives, all functions accomplished at a central junction control center.

Evolution of modern electronic combustion control is traced and future capability forecast. *REA*

Operations-research study of steam-power-plant automation, *J K Dillard, Westinghouse Electric Corp, J L Everett, Philadelphia Electric Co*

Automatic power-plant control involves two distinct types of action, sequential and dynamic. Former covers opening and closing valves, and similar functions. Latter involves minimizing fluctuations of plant variables—temperatures and pressures, for example. To date most progress has been in the area of dynamic control. But now high-speed solid-state digital computers offer possibility of completely automating sequential control, as well.

Study team had these aims: (1) analyze dynamic characteristics and sequential-operational requirements (2) develop sequential logic diagrams (3) develop a mathematical model and establish its validity (4) develop new control concepts (5) indicate problem areas and (6) determine costs.

Equations for the mathematical model were tailored to Philadelphia Electric's Cromby Unit 2 to prove validity of the model-building technique. *ASME 61-SA-66*

continued

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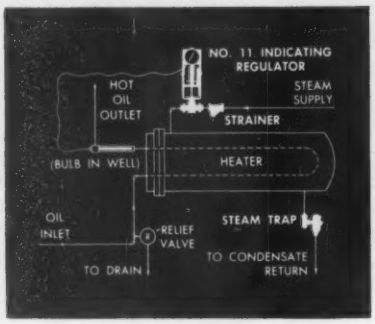
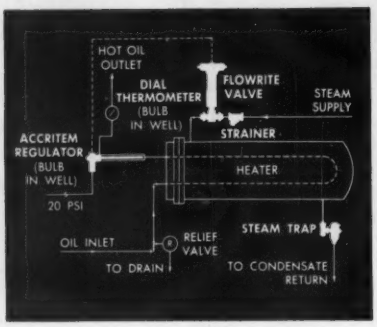


Outside power is not required by this system. The temperature indicating regulator is installed in the steam supply line, with a remote sensing bulb set in the hot oil outlet of the heater. A self-cleaning strainer preceeds the regulator, and a properly sized steam trap is used in the condensate return.



Easy temperature selection and a calibrated regulator dial are features of this system. In this case a control valve is used in the steam supply line. Temperature regulator and dial thermometer are installed in the hot oil outlet to give a constant visible check of operating temperature.

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Technical briefs

Begins on page 102

Hydraulics

Effect of high velocities on turbine pitting, *F L Lawton, M D Lester, Aluminium Laboratories, Ltd*

Cavitation damage has been observed on hydraulic-turbine runners at high gate openings in spite of acceptable sigma values. But short-time runs at these velocities cloud the picture and make determining rate of cavitation pitting extremely difficult. Now two accelerated field-test methods permit a quantitative examination: (1) Soft aluminum plates fitted to vulnerable areas accelerate pitting effect. (2) Paint containing tracer isotopes is applied; subsequent loss of radioactivity measures loss of metal.

Data collected at the Isle Maligne Hydro-Electric Plant over many years' operation is plotted, together with accelerated test data to show correlation and effect of velocity on cavitation damage. *EIC 61-EIC-2*

Design problems in condenser circulating-water systems for Lakeview Generating Station, *J T Wieckowski, Hydro-Electric Power Commission of Ontario*

For ultimate total capacity of 2400 mw, circulating-water system had to be designed for 3700 cfs; overall length is 1700 ft from pump house to discharge. And since they expect normal plant duty of only 32%, system designers provided for daily start and stop.

Axial-flow circulating pump proved out economically, but the hp rise to shutoff forced special startup unloading provisions to operate while entire system volume (equal to about 6-million lb of water) is accelerated to 9 fps. An overflow pipe spills back to suction well but maintains sufficient head on system to establish vacuum and initiate flow.

They use butterfly valves in the circulating system because: (1) they adapt to motor or hydraulic operation (2) flow throttling is easier (3) they need less space (4) weight is down. However, head losses are up slightly.

Air-removal equipment was sized to handle 11% of theoretically liberated air—a slight margin over that

PPG Fiber Glass Pipe Insulation is quickly installed, provides top thermal insulation at Fontainbleau Towers addition in Miami Beach. 100,000 ft of this insulation was used, as well as PPG Duct Liner and Duct Insulation.

"We chose PPG Fiber Glass Insulation Materials because they are easier to handle than any other insulation products"

. . . says Mr. Joseph Crabtree, President, Crabtree Insulation Company, Miami, Florida

Crabtree Insulation Company had the contract to install all pipe and ductwork insulation in the new 405-room addition to Fontainbleau Towers, Miami Beach. Choice of materials was given to the company.

Mr. Crabtree asked his superintendent what materials he felt should be used, and was advised that the men preferred PPG Fiber Glass Insulation Products because they were easier to handle.

As a result, Crabtree Insulation Company used 100,000 ft of PPG Pipe Insulation, 25,000 ft of PPG Neoprene-coated Duct Liner, and 25,000 ft of PPG Duct Insulation in the new Fontainbleau Towers addition.

Mr. Crabtree reports the insulation job went faster and with fewer problems than if other materials had been used. On the basis of this job and other jobs where he had used PPG materials, he would recommend PPG with no hesitation to other contractors.

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PPG has a wide range of fiber glass thermal and acoustical insulation products that speed installation, provide excellent insulating properties, give long service life with little or no maintenance. If you haven't tried them, get full information by contacting your nearest PPG Fiber Glass Sales Office, or by writing *Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Pennsylvania.*

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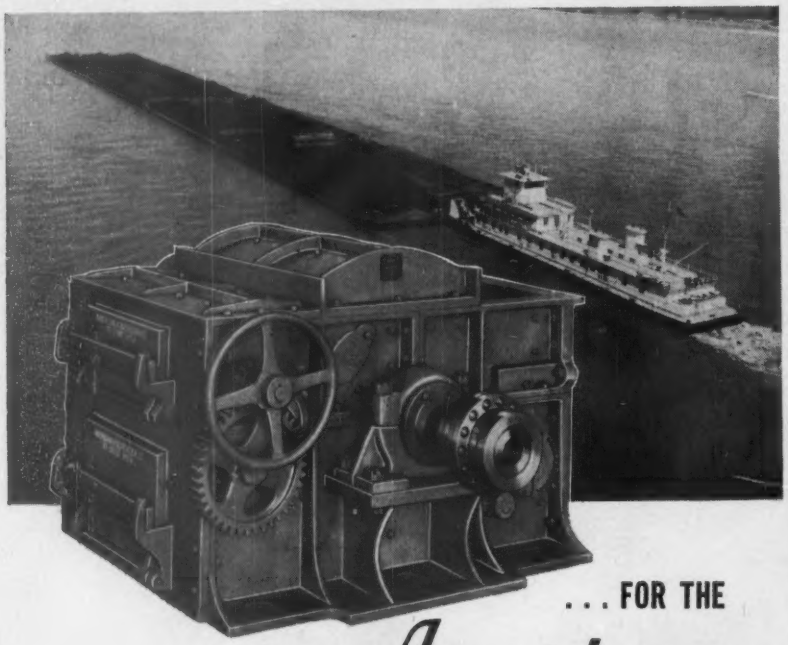
12 BARGE LOADS OF COAL IS BUT A SINGLE DAY'S WORK



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Technical briefs

Begins on page 102

expected to stay in the system. Air-removal-equipment capability set siphon height of 28 ft.

To prevent frazil ice (ice crystals in the water) from forming, water-box drains connect through a service-water line to the pump house. There warm water is diffused at the trash racks. For startup protection, boiler blowdown is routed to the intake canal, again diffusing in front of the pump-house intakes. *EIC 61-EIC-14*

Lubrication

Gas turbines and fire-resistant lubrication, *O M Fletcher, Texas Eastern Transmission Corp*

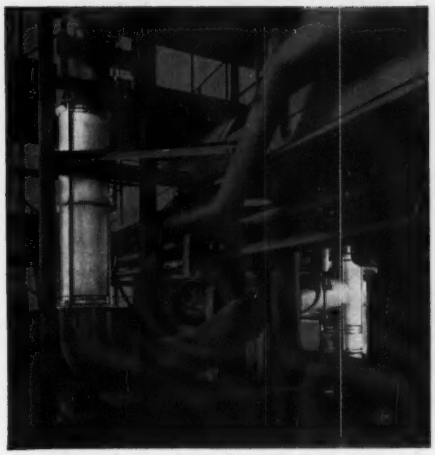
Since 1958, 53,600 hp of remote gas-turbine-driven compressors have been operating with phosphate-ester lubricants. In the beginning, lab tests prompted use of this fire-resistant lube. See POWER, Aug 1960, pp 83 to 85. Experience has confirmed findings, and additional use is planned.

Design modifications found necessary to accommodate this lubricant included substituting compatible materials for standard gaskets, thread compounds, O-rings and seals. All paint had to be removed from oil-exposed areas. Because some areas in the lube system are inaccessible, additional filtering is a necessary precaution to protect the oil-seal system.

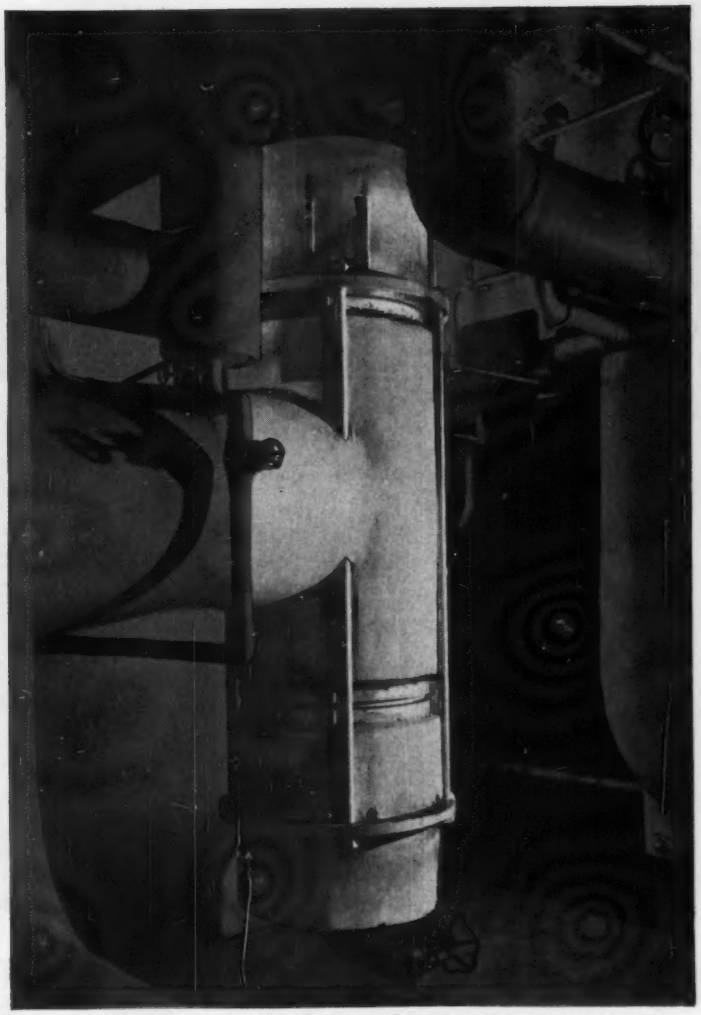
In view of specific heat and gravity differences between hydrocarbon and phosphate-ester lubricants, it seemed reasonable to assume better heat-transfer characteristics for the phosphate ester. Experience has indicated that this is true, but no rigorous tests have been run as yet. *ASLE 61 AM 4D-3*

Bulk grease handling, *A C Gartley, American Oil Company*

History of bulk grease handling is traced from the standard 400-lb drum of the 1940's to date. In many instances these drums are still used and large inventories kept in central storage. In the early 1950's, bulk grease trailers were designed, planting the



In the foreground, a 20" ZALLEA Universal Expansion Joint absorbing lateral movement.



At a major Eastern oil refinery, a 20" Zallea Pressure Balanced Expansion Joint installed on a steam turbine exhaust nozzle.

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Six tough Zallea Expansion Joints protect three 10,000 kw turbine generators from the wallop of thermal stresses . . . real hot-spot duty. Each generating unit has a 20" pressure balanced, self equalizing expansion joint installed at the turbine exhaust nozzle to absorb reaction load due to internal pressure acting against the turbine casing. A 20" universal expansion joint absorbs lateral deflection in the pipe run from the pressure balanced unit. Temperatures range from 0° to 615° at start-up, back to 475° in operation, at 200 psig. To cope with these cycles, the turbines demand—and get—the maximum reliability of Zallea Expansion Joints.

Whatever the service, none of the many factors affecting Zallea Expansion Joint reliability are left to guesswork. Zallea Expansion Joints are hydraulically formed. Advanced welding techniques insure welds having the same thickness, strength and physical properties as the parent metal. Zallea has done more cyclic testing to destruction than all government agencies and industrial firms combined. Zallea has produced more expansion joints than any other manufacturer . . . offers you more application engineering experience. These are just a few of the reasons Zallea Expansion Joints can and do outlive the equipment they serve. Sooner or later, ordinary expansion joints hand you a bill for unscheduled downtime, lost output.

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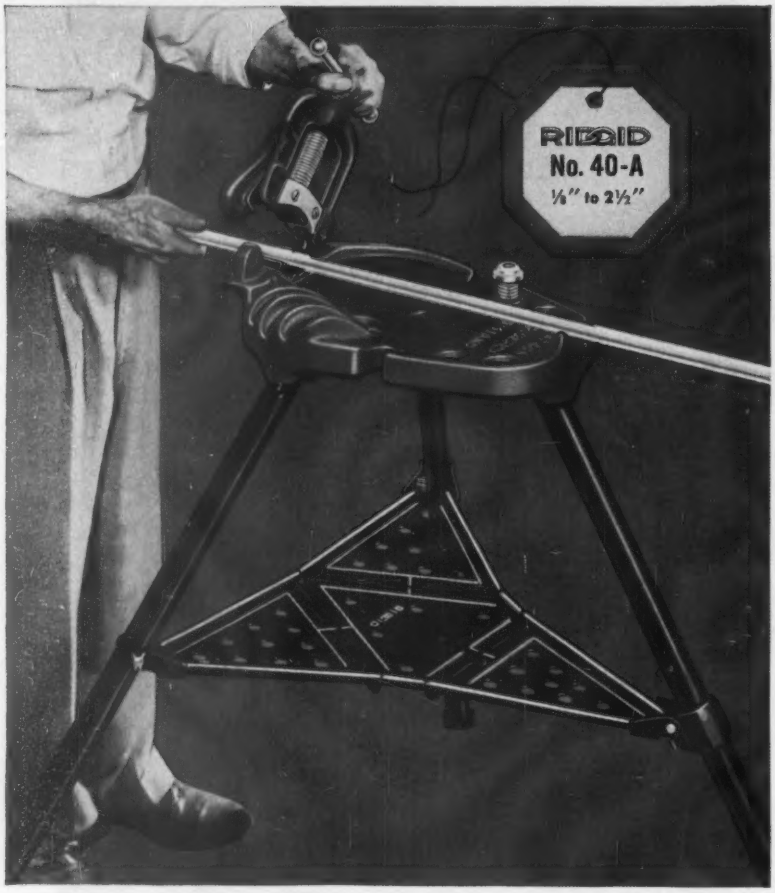

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Technical briefs

Begins on page 102

seed of bulk handling, but for a few years no actual unit was put in operation. Then, in 1955, 4000-lb containers were placed in steel-mill service. These tanks featured a pneumatic follower to wipe the tank walls clean. Later, round tanks holding 5000 lb were built without a follower.

Now bulk-grease-handling containers hold up to 12,500 lb and more. Some tank trailers have been converted to bulk grease handling by simple pump and valving changes; tank-trailer capacities are up as high as 40,000 lb.

In solving the bulk-grease-handling problem, suppliers must design and build equipment based on (1) location of grease-manufacturing plants (2) number of potential customers (3) capacity of customers' systems and (4) types of greases needed. *ASLE 61 AM 3A-1*

To obtain complete text

Material for these abstracts comes from the following sources. Order complete paper from source, *not* POWER.

AIEE: American Institute of Electrical Engineers, 33 W 39th St, New York 18, N.Y. Members, 50¢; nonmembers, $1.00.

APCA: Air Pollution Control Assn, 4400 Fifth Ave, Pittsburgh 13, Pa. Members, $1.00; nonmembers, $1.50.

APC: American Power Conference, Illinois Institute of Technology, Technology Center, Chicago 16, Ill. Papers will be published as a book costing $8.00.

REA: Rural Electric Generating Cooperatives Conference. In most cases, complete papers are available direct from the author at no charge.

ASME: American Society of Mechanical Engineers, 29 W 39th St, New York 18, N.Y. Members, 50¢; nonmembers, $1.00.

EIC: Engineering Institute of Canada, 2050 Mansfield St, Montreal 2, Quebec, Canada. Price, 50¢.

ASLE: Contact American Society of Lubrication Engineers, 5 N Wabash Ave, Chicago 2, Ill. Members, 50¢; nonmembers, 75¢.

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New free literature

General equipment and key materials for systems engineering

101 **Reference table** includes conversions—in. to cm, w to hp. In wall-chart form, it is available from Precision Equipment Co

• **Instrumentation**

102 **Tachometer,** panel-mounted for materials-handling installations, is described in data sheet from Metron Instrument Company

103 **Rheostat,** dissipating 12½ w, is subject of fact sheet. Hardwick, Hindle Inc

104 **Thermo-regulators** and thermostats are subject of 12-p catalog 18-B. Units hold temperature baths constant, other regulators change control point rapidly over fixed temperature range. H-B Instrument Company

105 **Gages** indicating draft, differential gas pressure and temperature and pneumatic impulses from transmitters are detailed in 12-p bulletin 321.11. Republic Flow Meters Company

106 **Metal - sheathed - thermocouple** pamphlet describes multipoint sensing and hard-to-get-at applications in its 8 pp. Trinity Equipment Corporation

107 **Instruments** and systems for measuring, recording and testing are illustrated in revised 48-p catalog G-10b. Price ranges and specs are given so user can size up his needs, performance- and budget-wise. Minneapolis-Honeywell Regulator Company, Industrial Div

108 **Thermowells** for thermocouple protection are topic of 8-p circular TT-301. Wells come in monel, nickel, steel, Inconel and other materials. Trinity Equipment Corporation

109 **Level-control** specifications for liquids, powders or solids are found in 4-p brochure from Fielden Electronics, Inc

110 **Transistorized analog-** and telemetering-system schematics are given in 8-p bulletin GEA-7163. General Electric Company

111 **Potentiometer** can be tapped and phased in the field for fast modification. Data sheet gives details. George Rattray & Co, Inc

112 **Data-logging system** with 160 channels is topic of spec sheet N-07(4). Leeds & Northrup Company

113 **Pneumatic receiver** with 4-in. chart width is introduced in 4-p folder A134 from The Bristol Company

114 **Peripheral equipment** for plug-in connection to manufacturer's computer is listed in 8-p booklet SP140. Packard Bell Computer

115 **Photoelectric tachometer** is portable, measures rotating- and re-

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Electrical systems 110
Steam, hot-water systems 114
Fluid-handling systems 116
Mechanical-transmission systems 118

ciprocating - machinery speeds. Fact sheet is available from Simonds Worden White Company

• Maintenance

116 **Lip-seal leakage**—its causes and prevention through use of lip-seal testing machines—is discussed in 4-p publication. General Motors Research Laboratories

117 **Equipment-shutdown planner** is wall chart SM-5732. Items involved in shutdown are shown and space is provided for listing time and manpower needs. Westinghouse Electric Corporation

118 **Flame-spraying** applications in electric-power generating stations—boiler-feed-pump castings, furnace parts, pump sleeves—are reported in 10 pp from Metco Inc

• Valves, fittings and specialties

119 **Relief-unloading valve** for steam, air, gas and fluid-control service is feature of 4-p folder S-5. Golden-Anderson Valve Specialty Company

120 **Air-operated valves** are subject of 6-p booklet 134-A. Diaphragm units control corrosive and non-corrosive liquids and gases remotely or automatically. Hills-McCanna Company

121 **Solenoid valves,** 2 way, are designed for normally closed 1000-psi operation. Form V5128 is offered by Automatic Switch Company

122 **Space-saving needle valves** are illustrated in 4-p circular 568. Valves are suited for instrument-line, gage, bypass and orifice-meter service. Lunkenheimer Co

123 **Split-body control-valve** construction and maintenance are chapters of 16-p brochure LB-4. Seat ring drops out when body halves are separated. Conoflow Corporation

124 **Positioner** for diaphragm- or piston-operated control valves also serves with pneumatic-drive units. Operation is covered in 4-p brochure 1077. Blaw-Knox Company, Copes-Vulcan Div

125 **Rubber-seat butterfly valves** sized from 3 to 144 in. are for vacuum to 150-psi pressures. 4-p catalog 6 is from Henry Pratt Company

126 **Ball valves**—top entry, flanged, shutoff and screwed-end bar stock—are featured in 16-p catalog. Pressure and temperature curves, dimension tables and drawings are chapters. Hydromatics, Inc

127 **"Gasket materials"** is title of 14-p booklet AD-190. Chapters deal with selection according to temperature and nature of fluid or gas contained. Garlock Inc

128 **Strainers,** Y-shaped and basket patterned, can have semi, cast and stainless steel as well as bronze bodies. Screens are per-

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NEW FREE LITERATURE continued ..... circle key numbers, page 109, for your copies

forated sheet metal or woven-wire mesh. Pressure-drop charts are included in 20-p catalog 61. O C Keckley Company

129 **Flexible-pipe connector** guide AM-9 discusses application, design and handling in its 16 pp. Checklist is included for ordering ease. Allied Metal Hose Co

- **Prime movers**

130 **Piston-ring** price catalog for large-bore diesel and gas engines includes material and cylinder-liner info in its 12 pp. Piston Products Inc

131 **"Improved installation techniques** for steam turbine-generator units" is title of 8-p bulletin. Turbine-generator test facilities are discussed. Allis-Chalmers Manufacturing Company

- **Lubrication**

132 **Molybdenum-disulfide additives** to increase lubricant temperature capabilities are feature of 20-p bulletin. Reducing frictional resistance between moving parts is diagramed. Hercules Packing Corporation

133 **Lubrication systems** — bucket, lubricant and filler pumps and injectors—dispense oil or grease. Installation and operating accessories are cataloged in 36-p booklet 82. Lincoln Engineering Company

- **Welding**

134 **Induction-heating unit,** 400 cycles, operates by a strip-chart program controller to simplify preheating and stress-relieving of arc-welded pipe joints. 4-p folder DM-157 is from Hobart Brothers Company

Air-conditioning systems

- **Air-conditioning equipment**

135 **Year - 'round air - conditioning** units use roof space for both heating and cooling of 1-story buildings. 24-p catalog describes application, installation and specifications. Melchior, Armstrong, Dessau Inc

136 **Air-conditioning equipment's** mechanical and design features are covered in catalog 560. Motor-hp requirements and cooling- and heating-coil selection info are given. McQuay, Inc

- **Refrigeration**

137 **Packaged chillers,** 2-to-30 and 20-to-100 tons semihermetic, are topic of 12- and 16-p bulletins 8022A and 8023A. Heat-X, Inc

- **Filtration**

138 **Compressed-air filter** removes condensed moisture, oil and pipe scale in 2-stage cleaning cycle. 4-p pamphlet 118 lists prices. R P Adams Company, Inc

Electrical systems

139 **Portable testing instruments**—ac and dc meters, current transformer used as an ac multiplier

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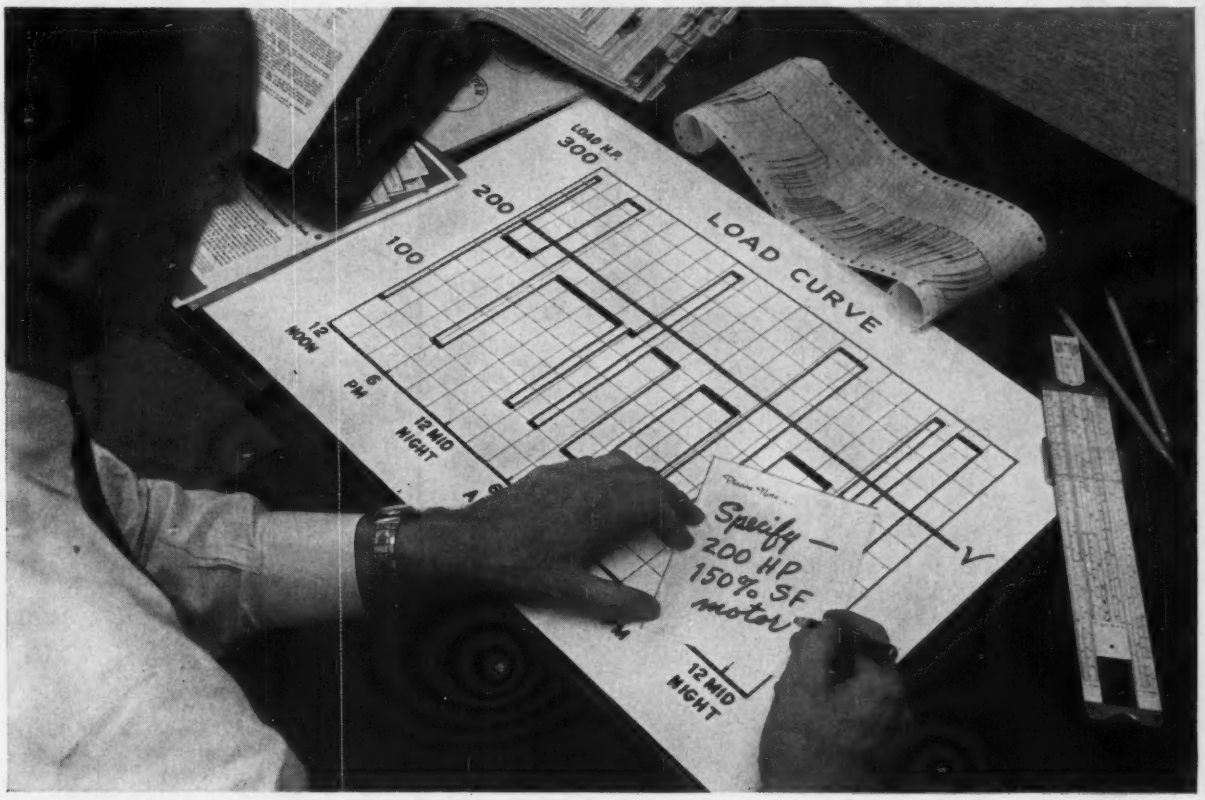
SILICONE NEWS from Dow Corning

Over-motoring Out-moded



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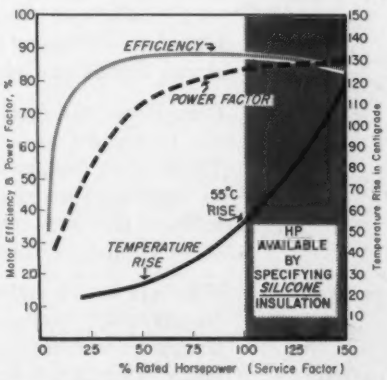

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New literature

Begins on page 109A

—and a power analyzer and circuit tester are featured in 8-p brochure Cir Z-54. Daystrom, Incorporated, Weston Instruments Div

140 **High-current test sets** are portable. 4-p folder SB-361 is offered by Multi-Amp Div, Multi-Amp Electronic Corporation

141 **Panel instruments**—ac and dc ammeters, milliammeters, microammeters and voltmeters — are subject of 6-p folder 01-113. Daystrom, Incorporated, Weston Instruments Div

142 **Ac power regulators** for automatic or manual control of power to electrical loads are subject of 8-p bulletin. Research, Inc

143 **Miniature oiltight pushbuttons** are shown in 12-p revised publication GEA-7127A. Nomenclature tables list types and colors available. General Electric Co

144 **Rectifier ammeters** and voltmeters are topic of data sheet GEZ-3352 from General Electric Co

• Generation

145 **Standby power systems** provide sine-wave ac from storage-battery packs. 4-p folder 61311 gives details. Electro-Seal Corporation

• Distribution and protection

146 **Silver-oxide-cadmium** battery is rechargeable. Its physical characteristics and uses are described in paper available from Yardney Electric Corporation

147 **Asbestos-cement conduit,** thin- and thick-walled, is feature of 12-p brochure TR-247A. Table lists conduit requirements alongside properties and performance factors of manufacturer's conduit. Johns-Manville, Pipe Div

148 **Cast-iron foot-switch** operation is diagramed in 4-p folder GEA-7086A. Selection guide includes nomenclature, contact arrangement and pedal operation. General Electric Company

149 **L-v power circuit breakers,** 15 to 4000 amp, are subject of 14-p catalog FB-1-6010. Ratings and application data are tabulated. Federal Pacific Electric Company

150 **Extended-arm** limit-switch specifications are given in fact sheet GEA-7312.1. General Electric Company

151 **Portable test units** for protective relays, 0.4, 1 and 2 kva, are discussed in 48-p bulletin SB-RT-1. Operation, selection tips and charts are chapters. Multi-Amp Div, Multi-Amp Electronic Corp

152 **Circuit-breaker selection** disk lets you determine physical and

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Power plant stretches diesel service -cuts maintenance costs- with

By C. F. KLENNER Carl Klenner is a specialist at helping customers with their lubrication problems. A graduate of the Michigan College of Mining and Technology, he has been serving commercial customers since 1948. He also attended the Company's Sales Engineering School.

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At Roseau, Minnesota, the Municipal Power Plant uses Fairbanks Morse Diesel Engines for the generation of the city's electricity. And since 1946, lubricating oils supplied by our Company have played an important part in the excellent maintenance of this plant.

For example, diesel unit number two was overhauled in 1954 after six years' service. At our recommendation, AMERICAN D&G Oil No. 53 was put in the crankcase at that time. After 19,000 hours of oil service, the unit was taken down again. All rings were free, bearings and rings showed minimum wear, and there was negligible carbon on the piston skirts. With AMERICAN D&G Oil, this unit has averaged 4,584 horsepower-hours per gallon of oil.

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American's C. F. Klenner checks performance reports with power plant superintendent Carl Grand.

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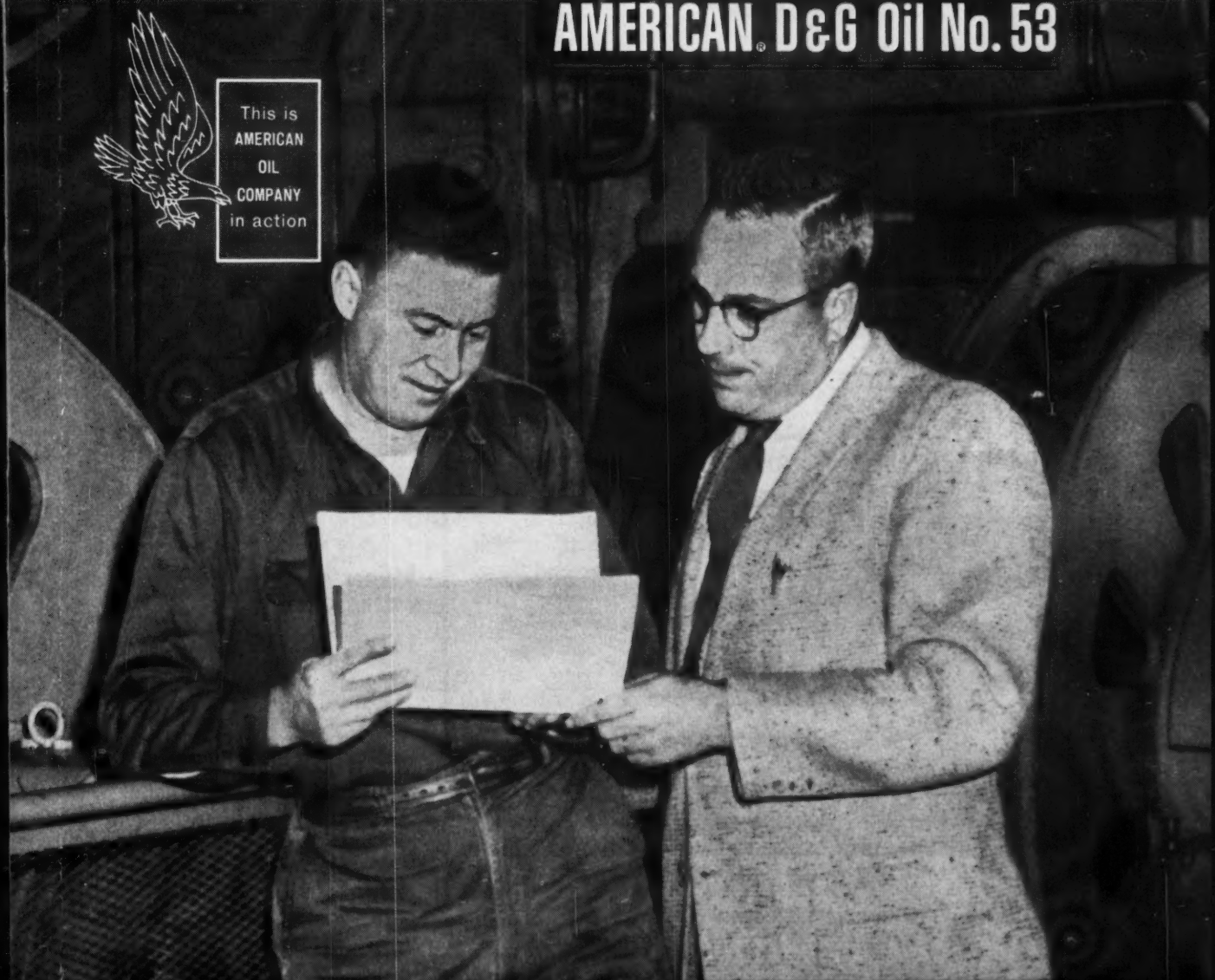

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Rotojet Electric Tube Cleaner thoroughly cleans straight tubes from 25/32" to 4" I.D. in boilers, condensers, evaporators, and heat exchangers so quietly that it can be operated without disturbing anyone.

This self-contained unit comprises a powerful motor, rotatably mounted on a stand, a required length of heavy duty flexible shaft, a 20 ft. cable, and a selection of heads, brushes, drills, and scrapers to meet any cleaning need. The motor swivels and rotates so that tubes on top, bottom, and sides can be cleaned without moving the unit. A few of the many types of heads available are shown below.

Bulletin 107 gives full details of this quiet, efficient, convenient tube cleaner. Send for it now.

Rotojet Electric Tube Cleaner with swing-frame head.

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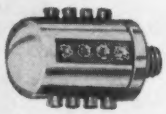


Expanding wire brush.

ELLIOTT COMPANY – ROTO PLANT
Tube Cleaner Specialists Since 1910
1071-53 Bristol Road, Mountainside, N. J.

New literature

Begins on page 109A

electrical characteristics of breakers in various types and sizes by rotating wheel. Westinghouse Electric Corporation, Standard Control Div

153 **Safety switches** and circuit breakers are described in 32-p pocket guide. Electrical operator for complete remote control is feature. Westinghouse Electric Corporation, Standard Control Div

• Application

154 **Shell type motors** are available in open, enclosed or liquid-cooled ratings from ½ to 150 hp. 4-p brochure is available from The Louis Allis Co

155 **Contactors** and starters, NEMA size 3 and 4, are diagramed in 8-p bulletin GEA-7326. Relay-heater-selection tables are given. General Electric Company

156 **Motor systems** are subject of revised 8-p publication F-1952. Advances in control-instrumentation and panel design are reported. U. S. Electrical Motors Inc

157 **Capacitors** for ac applications are subject of service guide C-914. 20 pp contain motor-capacitor replacement information; chart compares capacitors of different manufacturers. Price: 10¢. Sprague Products Company

158 **Mercury-vapor-lamp** maintenance and construction are features of 8-p booklet. Lumen output is charted. Westinghouse Electric Corporation, Lamp Div

159 **Minimum illumination levels** are recommended in 16-p section of ISE's lighting handbook — primarily for manufacturers and electric utilities. Price is 20¢ a copy. Illuminating Engineering Society

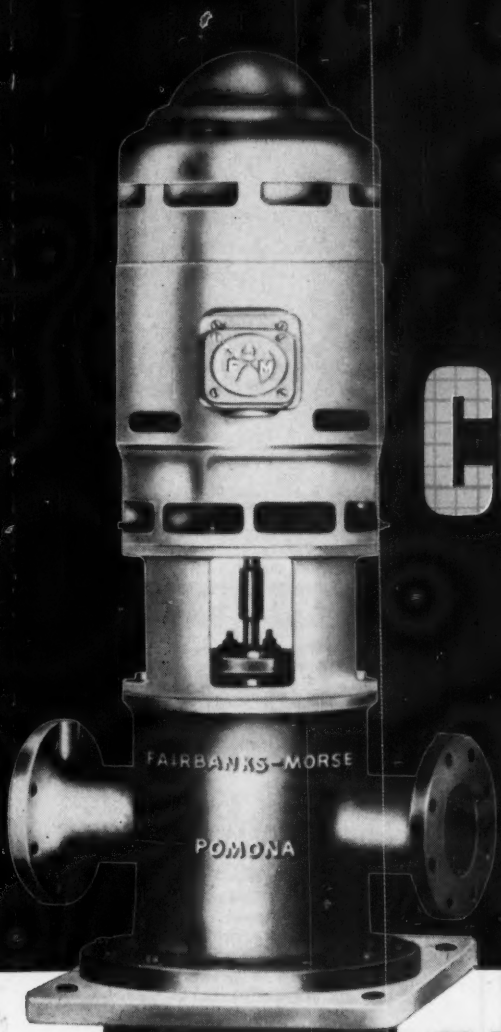
160 **Floodlights** for general-purpose, outdoor and hard-to-light situations and mercury-vapor floods are subjects of four 4-p bulletins: GF 860, SF 960, QL 15-161 and MF 261. Appleton Electric Company

Steam and hot-water systems

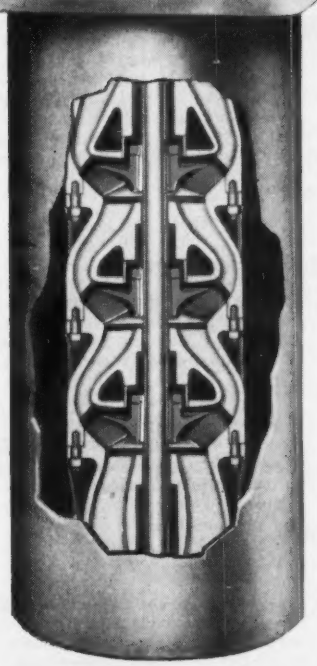
161 **Silicon-rectifier** conversion unit for electrostatic precipitators installs without replacing equipment other than old rectifier. 4-p brochure is available from Buell Engineering Company, Inc

162 **Electrostatic-precipitator** operation is described in 12-p brochure 2128. Electronic controls and h-v rectifier are illustrated. American-Standard Industrial Div

163 **Air-pollution control** techniques and equipment—precipitators for



new COST-SLASHING SERVANTS for industry!



F-M TURBINE POT PUMPS

Now . . . get true pumping *economy* and *versatility!* F-M Turbine Pot Pumps do the trick—*and take less plant space than other types of pumps!*

Our unique "pot" principle prevents need for space-taking pits . . . helps attain higher pressures.

Compact F-M Turbine Pot Pumps are ruggedly built for longer life—continuous, trouble-free operation. Each pump provides higher output (capacities from 10 to 30,000 gpm), with pressures up to 3000 psi.

F-M Turbine Pot Pumps are *flexible* for *extra* savings! Their unique, close-coupled turbine design makes them adaptable to changing operating conditions with minimum expense.

F-M Turbine Pot Pumps are the answer to many liquid-moving needs—from clear water to hot or cold, corrosive or non-corrosive, volatile, or non-volatile liquids. They are available with mechanical seals for any pressure range.

Fairbanks-Morse has a quality-engineered Turbine Pot Pump for almost every range of industrial service . . . water supply, air conditioning, water flood, process-pumping. And—Fairbanks-Morse service will help you enjoy continuous pumping operations . . . all the time . . . anytime!

For further information write: Pump & Hydraulic Div.; Fairbanks, Morse & Co.; Kansas City, Kansas.

FAIRBANKS MORSE

A MAJOR INDUSTRIAL COMPONENT OF

FAIRBANKS WHITNEY

For more facts circle 264 on Reader Service card, p 109

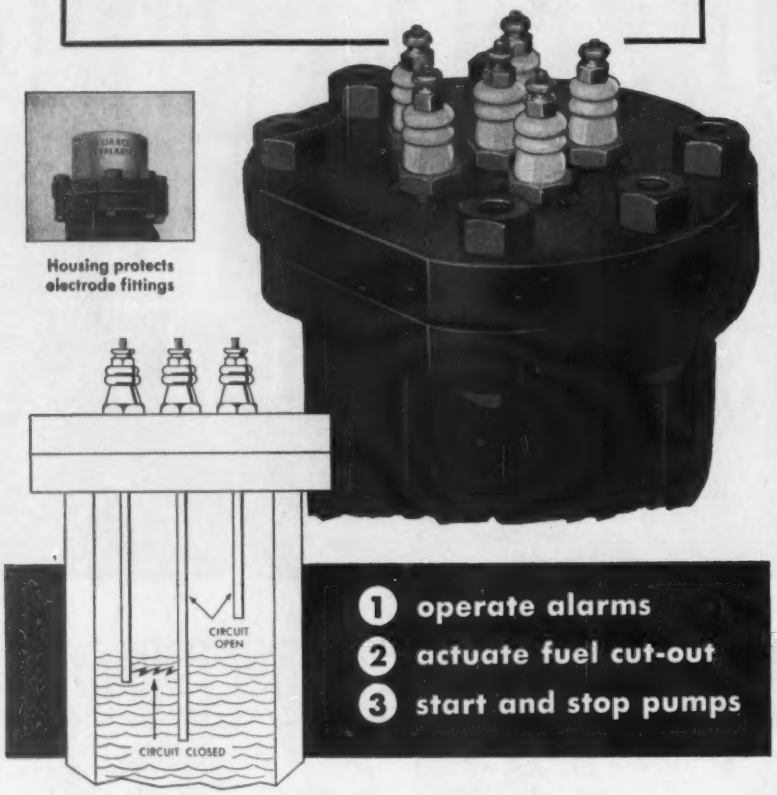
What could be simpler?

Your boiler water is a conductor;

Its rise and fall can be made to make and break circuits;

Simple efficient control to 1, 2, 3 (below)

Housing protects electrode fittings



1. operate alarms
2. actuate fuel cut-out
3. start and stop pumps

RELIANCE ELECTRODE LEVALARMS GIVE YOU *INSTANT ACTION* — at exact pre-set water levels. Minute transformer-isolated currents pass through boiler water in the column — actuate controls through relays. From one function (fuel cut-out or low water alarm) to combinations of up to *five or more* are possible with a Levalarm: low or/and high water level alarm, fuel cut-out, start and stop pumps, etc.

Electrode Levalarms are entirely electrical; they do not depend on vacuum tubes or magnets — have no stuffing boxes or bellows. Models available for every pressure or temperature.

It will pay you to get full information on Reliance Levalarms. Write the factory or contact nearest Reliance Representative.

The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio

Reliance BOILER SAFETY DEVICES

New literature

Begins on page 109A

nuclear subs, automated controls and silicon rectifiers—are topic of 12-p bulletin 500. Company's services are enumerated. Research-Cottrell, Inc

164 **Firebrick** is used in prepared atmospheres for direct exposure and backup insulating. 4-p folder IN-294A is from Johns-Manville

165 **Steam traps** drain drying, heating and processing equipment operating at 1- to 250-psig steam pressures. 4-p bulletin 115 gives details. Stickle Steam Specialties Co

• Controls

166 **Pressure-control hookups** to improve existing regulating systems are explained in application guides, A7/11-13. Guides show inexpensive ways to provide remote shutoff. Spence Engineering Co, Inc

167 **Distillation-rate control** and temperature control with self-operated regulators is topic of six guides, A12-14/18. Eliminating pressure-reducing valves on regulator applications is discussed. Spence Engineering Co, Inc

Fluid-handling systems

168 **Fans,** air washers and exhaust systems of PVC handle corrosive gases and liquids. Chemical-resistance data for normal- and high-impact PVC and metals is tabulated in 36-p catalog F. Industrial Plastics Fabricators, Inc

169 **Aftercoolers** for compressed-air and gas applications have 30- to 5650-scfm air capacities. Floating tube-sheet end incorporates weep holes in retaining ring so shell- and tube-side fluids don't mix. 8-p bulletin 120 is from Davis Engineering Div, Tube Reducing Corp

• Compressors

170 **Air compressors,** gasoline- and electric-driven units, start and stop or run constantly. They come with horizontal or vertical tanks. 16-p catalog 20 gives details. Lincoln Engineering Company

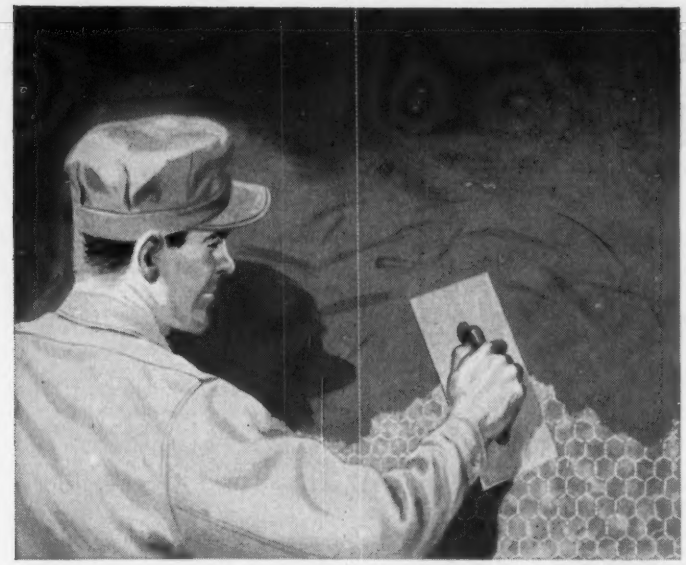
• Water treatment

171 **Electrodialysis-process** brochure contains flow diagrams of brackish-water conversion to fresh. Aqua-Chem, Inc

• Pumps

172 **Sealless-leakproof-pump** design, operation and selection are covered in 4-p folder 1100-1. Chempump Div, Fostoria Corporation

continued



You get 20% MORE COVERAGE

with EAGLE-PICHER SUPER "66" insulating cement

for temperatures up to 1800 F.

Because Super "66" Insulating Cement gives you less shrinkage (volumetric shrinkage wet to dry only 18½%), you get up to 20% greater dry coverage (50-55 bd. ft. per 100-lb.), with uniform thickness for better protection and strength. Result: You save warehouse space, time and labor costs.

Eagle-Picher Super "66" Insulating Cement *sticks to hot or cold surfaces.* It contains a special rust inhibitor that actually *prevents corrosion.* In addition Super "66" is easy to apply . . . reclaimable when used to 1200 F . . . and offers one of the most effective thermal barriers known. Super "66" can be applied on irregular shapes and usually requires no reinforcing on applications up to 1½ inches thick.

Eagle-Picher produces a line of industrial insulations for all temperatures from below zero to over 2000 F. See our complete catalog in Sweet's Plant Engineering File or write for descriptive material.

Since 1843

EAGLE EP PICHER

EAGLE-PICHER

The Eagle-Picher Company • General Offices

Dept. P-961 • Cincinnati 1, Ohio

Member of National Insulation Manufacturers Association

This LITTLE trap does a BIG trapping job— and reduces the cost of discharging condensate

NEW NICHOLSON N-150 THERMOSTATIC STEAM TRAP

... All steel construction for rugged durability.

... Design simplified for quick, low cost maintenance.

... Compact, lightweight, easily installed. Can be inspected without breaking pipe connections.

... Equipped with Nicholson steam-saving Baffle*.

For lowest cost-per-pound of condensate handled, this trap is by far your best buy. Like all Nicholson Thermostatic Traps, it opens ONLY when necessary . . . that is, when sufficient condensate collects in trap body to surround the Monel bellows . . . ONLY then does the pressure inside the bellows reduce below line pressure, the resulting differential causing bellows to contract and instantly activate complete discharge. Body is cast steel and cover forged steel. Cover screws, valve and valve seat are hardened stainless steel. Just *one* working part, so maintenance is practically nil. In ½" and ¾" sizes. For pressures from vacuum to 150 psig. Write for details, including the name of the Nicholson man in your area.

**Patent applied for*

W. H. NICHOLSON and COMPANY

12 Oregon Street • Wilkes-Barre, Pa.

Our 80th Year

New literature

Begins on page 109A

• Controls

173 **Water meter's** parts are interchangeable, so you can repair, reset and calibrate unit in your shop. 8-p bulletin is available from Neptune Meter Company, Liquid Meter Div

174 **Actuator** converts hand-operated valves to automatic. Installation is pictured in 4-p catalog V-200. C H Wheeler Mfg Co

175 **Temperature regulators** are topic of 8-p brochure TCV-1. Units are available in self- or pilot-operated models from ¼ to 6 in. OPW-Jordan

176 **Pilot-valve unit** is pneumatically operated to control flow or pressure in water-filtration or waste-treatment plants. 3-p spec sheet 286-05.201-1 is available from B-I-F Industries

177 **Turbine flowmeters** for liquids, gases and cryogenics are described in 12-p booklet 1384C. Meters are used for automatic process control in batching and blending systems. Cox Instruments Div, George L Nankervis Company

Mechanical-transmission systems

178 **Conveyor-belting** maintenance wall chart covers storage, alignment, impact idlers, drive-pulley lag and inspection. Hewitt-Robins

179 **Adjustable-speed drives** are magnetic, come in 50 to 2500 hp for extruder, pump and draw-bench applications. 6-p bulletin 3650 is offered by The Louis Allis Co

180 **Spiral-bevel speed reducers** are topic of catalog J-25. Features of vertical and horizontal units, overhung- and thrust-load capacities and hp and thermal ratings are contained in its 32 pp. Hewitt-Robins

181 **Self-sealing-coupling** applications in fluid systems are topic of 20-p booklet 629. Illustrated bulletin aims to give engineer or technician general coupling info. Aeroquip Corporation

182 **Flexible cushion couplings**—flywheel, standard and high speed—absorb vibrations and compensate for shaft misalignment and end float—topic of 24-p brochure 901B from Dodge Manufacturing Corporation

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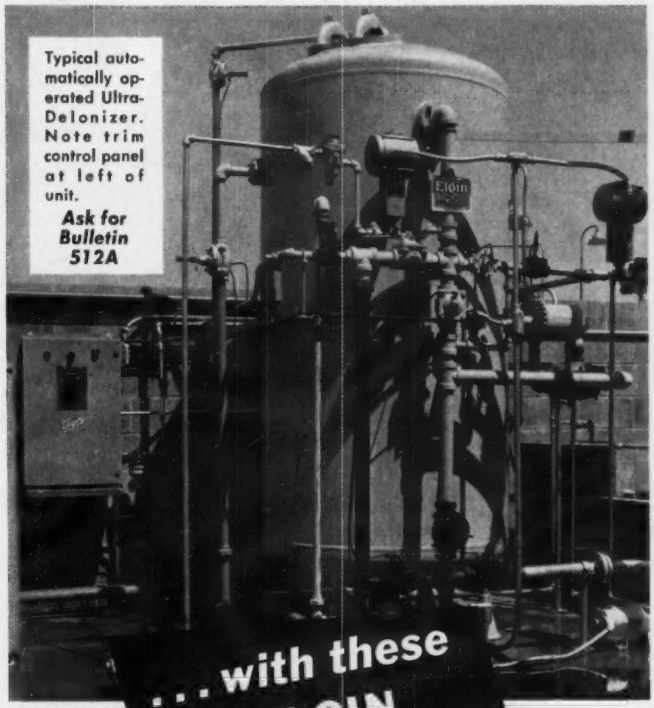
Engineering job market in 1961 is "cautious and competitive," says Columbia U's placement director.

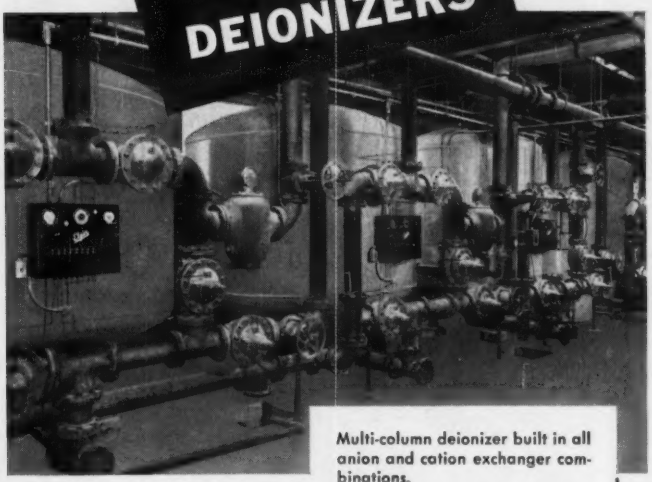
MINERAL-FREE WATER



Typical automatically operated Ultra-DeIonizer. Note trim control panel at left of unit.

Ask for Bulletin 512A

...with these ELGIN DEIONIZERS



Multi-column deionizer built in all anion and cation exchanger combinations.

Ask for Bulletin H4

—from equivalent of distilled up to 18,000,000 ohm quality

Whatever the quality of water you need—even up to 18,000,000 ohm purity—Elgin can supply the correct type and size deionizer to deliver it. Standard mixed-bed Elgin Ultra-DeIonizers are capable of producing water having an average of less than 0.5 ppm total ionizable solids, a specific resistance averaging in excess of 1,000,000 ohms and free of silica and CO_2. Employing special ion exchange materials, Ultra-DeIonizers are also built to deliver water of up to 18,000,000 ohm quality.

Elgin multi-column deionizers in various anion and cation exchanger combinations, both with and without degasification and mixed-bed "scavenger" units, are also widely used to provide water of any chemical purity desired.

While all Elgin deionizers are available in standard models, most buyers choose the exclusive Elgin "Double Check" type because its ingenious manifold arrangement (1) guards against loss of valuable ion exchange material (2) permits a deeper demineralizing bed (3) allows more effective backwashing (4) increases regeneration efficiency. This all adds up to a marked increase in high quality water output.

Whether for makeup purposes or processing requirements, chemically pure water delivered by an Elgin Deionizer costs so little considering the big job it does. And from simple manual control to fully automatic operation, you can rely on Elgin equipment to give that uncompromising quality and trustworthy service for which Elgin has been known more than a half century .

The technical assistance of the nearest Elgin representative is as close to you as your phone. Call or write for information.

ELGIN WATER CONDITIONING SINCE 1908

ELGIN SOFTENER CORPORATION

130 N. Grove Avenue, Elgin, Illinois

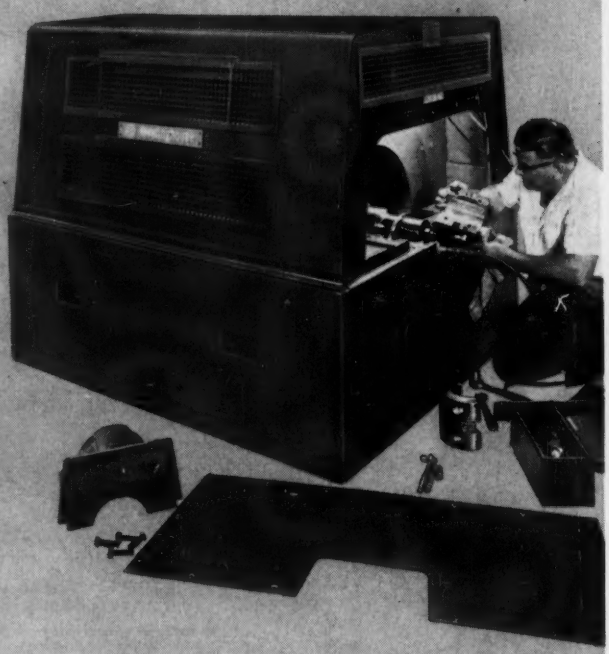
Representatives in principal cities • In Canada: G. F. Sterne & Sons Ltd., Brantford

9:02

Motor stopped; disassembly begun.

9:20

Sufficiently disassembled
to permit bearing inspection.



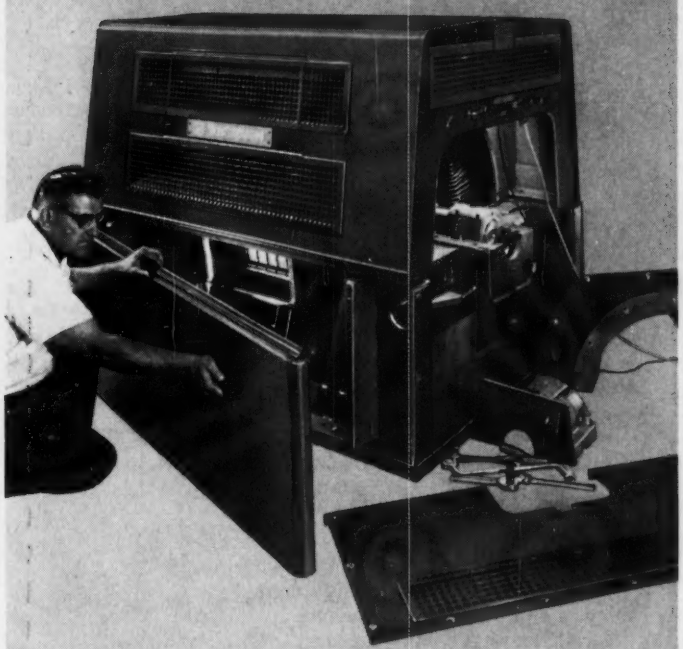
Westinghouse F/A motor completely disassembled in 90 minutes

"F/A" means "Fully Accessible" . . . Only 90 minutes are required for a complete disassembly. After cleaning, inspecting and servicing, the F/A motor can be completely reassembled and put back in operation in about two hours.

No other motor can be serviced so quickly. One electric utility maintenance engineer estimates that

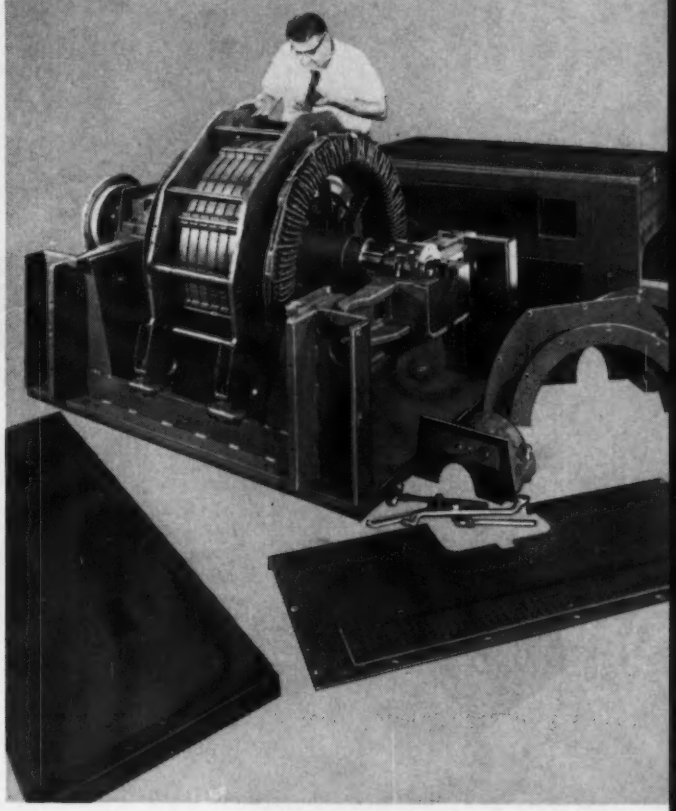
9:40

End covers, side panels, air shields removed. Winding inspection now possible.



10:32

Complete disassembly possible for major cleaning, inspection and servicing.



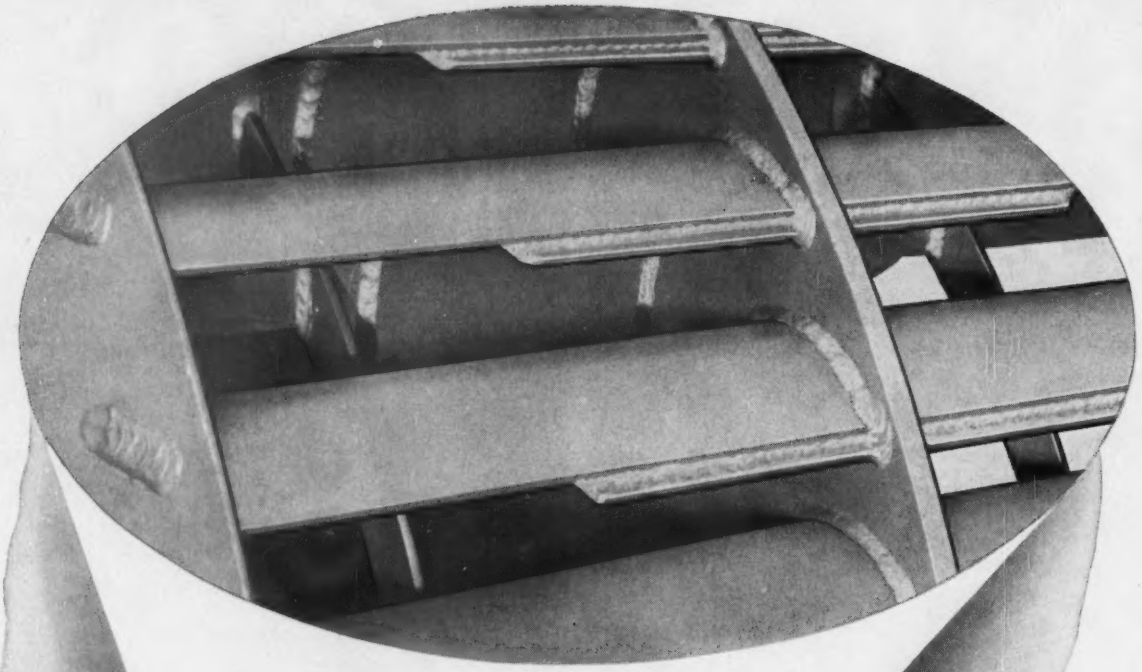
a Westinghouse F/A motor can be serviced in about one-fourth the normal time.

F/A motors are available in ratings from 250 hp/600 rpm to 7,000 hp/3600 rpm. For more information, call your Westinghouse Representative. Or, write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's*

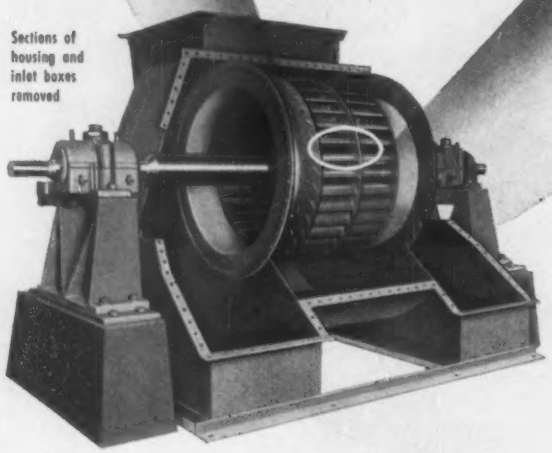
J-15022

Westinghouse

For more facts circle 269 on Reader Service card, p 109



RIGHT WHERE THEY BELONG . . . . . *wearing plates on the FACE of the blades*



Sections of housing and inlet boxes removed

Here's another feature you get only from Clarage. The Type DN Dynacurve induced draft fan, when equipped with wearing plates, has these abrasion-resisting steel plates welded to the *face* of the wheel blades.

Result: *extra* service life.

Don't settle for less. Choose the Clarage Dynacurve fan with its rugged wheel of 36 radially deep blades . . . minimum floor space and height requirements . . . bolted scroll liners for easy replacement . . . and numerous other distinctive features.

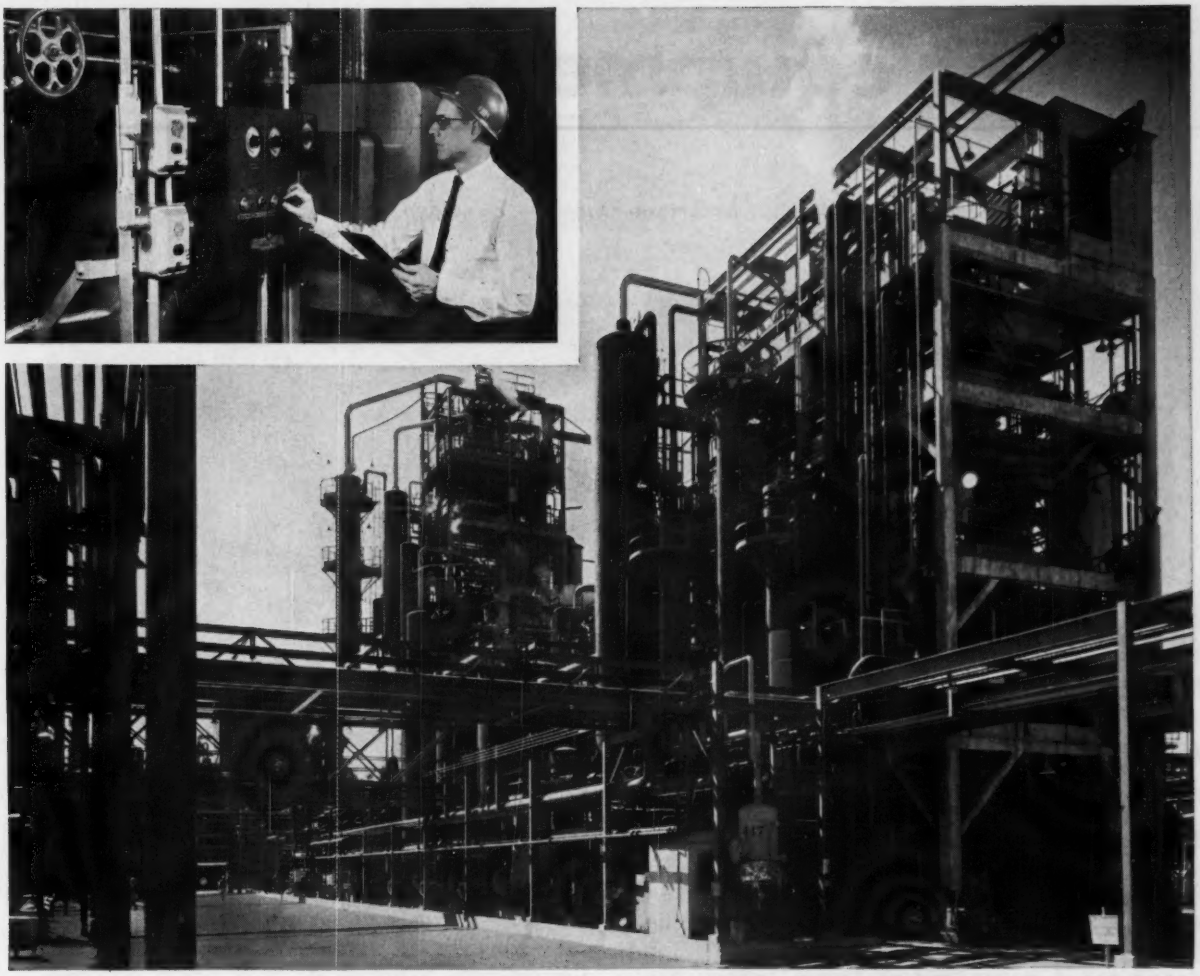
Contact our nearest office for complete data.

Dependable equipment for making air your servant

CLARAGE FAN COMPANY

Kalamazoo, Michigan

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal



INSET: Control panel for softeners at Plastics Division, Allied Chemical Corp., Philadelphia

AMBERLITE® 200...answer to ion exchange resin breakdown problem at Allied Chemical

This is the problem the Plastics Division of Allied Chemical Corporation at Philadelphia has in softening boiler water for power generation: 1) Water supply—municipal water containing oxidants plus manganese, an oxidation catalyst. 2) Hot waste streams heat raw water to 60°-100°F.

These severe conditions produced this ion exchange history in 2 softeners: 1) First ion exchange resin used was a conventional high-capacity polystyrene cation resin. Relatively rapid decrosslinking made rebedding necessary in about 2 years. 2) Second charge—more highly crosslinked polystyrene resin used; sodium sulfite added to water to curb oxidants. Rate of decrosslinking slowed down; but after slightly more than 3 years, resin replacement was again necessary. 3) At that time, AMBERLITE 200 became commercially available. This resin was installed after thorough pilot-plant testing. To date, no decrosslinking is evident.

In resistance to oxidative decrosslinking and to bead cracking from physical stresses such as osmotic shock, AMBERLITE 200 is unmatched by any commercially available cation exchange resin.

Write for AMBERLITE 200 literature, and a brochure giving many other case histories of AMBERLITE 200 performance. Also ask for a 16-page booklet illustrating functions AMBERLITE ion exchange resins perform in power generating, chemical, electronic, and other industries.

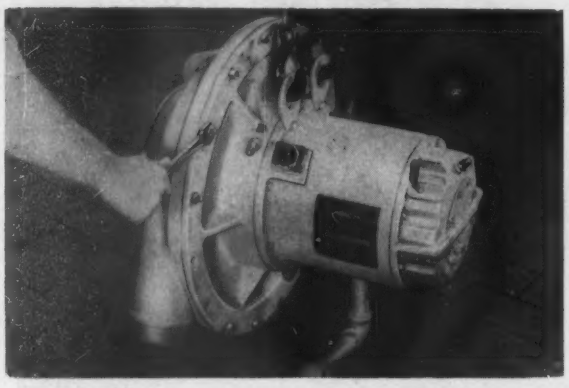
ROHM & HAAS

PHILADELPHIA 5, PA.

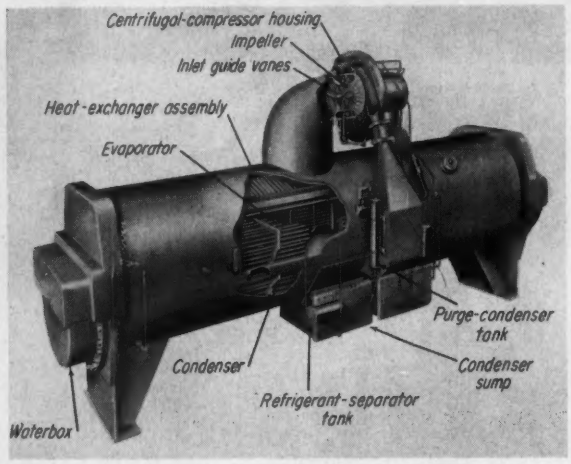
For more facts circle 271 on Reader Service card, p 109

Plant equipment news... Your

For more data on these developments, circle key numbers on Reader Service card, p 109



REFRIGERANT absorbs heat generated by 18,000-rpm motor



DESIGN combines condenser and cooler in common shell

A unique high-speed motor reduces size of packaged centrifugal cooling unit

1 • Hermetic-refrigeration unit goes through a standard-size doorway completely assembled. Packaged design is factory-piped and -insulated; it requires no auxiliary water and refrigeration piping or control-tube installation on job site. Eight sizes handle 50- to 100-ton refrigeration capacities, require less floor space. A liquid-refrigerant-cooled electric motor drives the centrifugal compressor at 18,000 rpm on 480-v 3-phase 300-c current. Refrigerant from condenser sump enters the l-p motor housing atmosphere. Change of state from liquid to vapor at motor windings permits refrigerant to absorb all heat generated within the miniaturized motor. Bearings are motor-cooled. A motor-generator-exciter converts 60-c line current to 300-c for the motor. Power-unit generator is operated from any rotary prime mover—steam turbines or internal-combustion engines can serve as standby power sources.

Conventional reciprocating compressors introduce lubricating oil into the system. A separator cleans refrigerant of oil by boiling, but when refrigerant and heat come in contact, a harmful acid is formed. Compressorless purge system in this unit utilizes the constant pressure differential between condenser and cooler to exhaust foul condenser gases.—American-Standard Industrial Div

Drive boasts simple design

2 • Hydraulic power unit provides variable-output shaft speed from constant-input speed. Yet to come — units for larger hp applications using design of this 5-hp model. Housing can be installed as a jack shaft or direct coupled to any power train. Basic component's four moving parts are continuously lubricated by oil submersion in the aluminum case. Simple design of 30-lb unit is reflected in price, maker states, so it can serve where less power is needed and a conventional mechanical-transmission system would cost too much.—Log-Master Services, Inc

Small user's needs are met

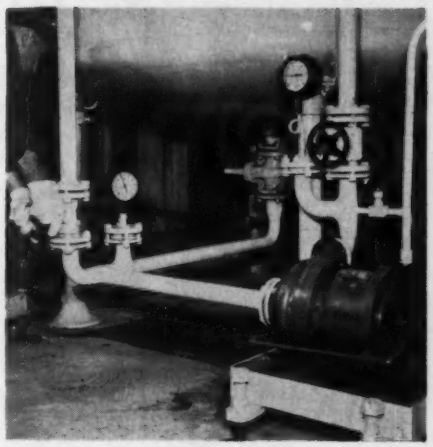
3 • Cooling-water treatment products meet needs of medium- and small-sized air-conditioning installations. Now operator can protect his cooling system without having to take an extra engineering course to do it. Four products are available in briquette form—a combination of polyphosphates, selected organics and inhibited dry acid for control of scale, corrosion and alkalinity. Feed is accurate and continuous with visual control using the company's stoker-feeders. Dry-acid content eliminates hazards of liquid-acid handling. — Dearborn Chemical Company

Detector battles pollution

4 • Condensation - nuclei detector gets its name because it detects these smog-forming particles. Its one part per 1000-trillion sensitivity may make more-effective air filters possible. Detector causes droplets to form around each nucleus. Nuclei then grow to microscopic size—large enough to scatter a light beam. Measured electronically, scattering indicates nuclei concentration in the man-made fog. Measurable cloud is formed in 5-thousandths of a sec, the manufacturer states. Detector is not commercially available as yet.—General Electric Company

information center for new products and materials

Centrifugal pump's bearings adjust themselves



5 • Totally enclosed and hermetically sealed centrifugal pumps handle toxic, inflammable or highly volatile liquids. The self-adjusting bearings automatically compensate for radial and axial wear, are designed for long life—minimum clearance between bearing and journal cuts down on grit and dirt damage. 13 sizes have discharges from 1 to 5 in., serve up to 120 psig and 40 to 250 F.

In event of excess loads, automatic thermoprotectors imbedded in stator windings prevent motor burnout. A 304-stainless-steel low-permeability can separates motor rotor's cavity from stator windings on standard models. Rotor bearings operate in and are lubricated by the fluid being pumped. Fluid passes through an external or internal recirculating line, dissipating motor heat. Entire unit can be taken apart quickly.—Buffalo Pumps Div, Buffalo Forge Company

Two-ratio transformers

6 • Transformers for high-current metering and relaying on l-v systems come in single or double ratios. 600-v units have ratings of 800 to 4000 amp with 33 1/3 to 100% more overload capacity, maker claims. They can be flush-mounted for a vertical bus coming through a platform or a horizontal bus extending through a wall. Dual-ratio units have 3- or 4-terminal arrangements. Primary opening is 5½ in. in diameter and takes a 4-in.-sq bus or multiple cables.—Westinghouse Electric Corporation

Units regulate heavy loads

7 • Automatic voltage regulators are for 50/60-cycle 3-phase applications requiring constant output voltage with zero waveform distortion. Standard assembly ratings: 460-v nominal output voltage, 380- to 520-v input range, adjustable output range of 440 to 480 v. Company boasts correction rate of 0.28 sec per volt, insensitivity to load magnitude and full circuit protection. Re-entry rings and helical coils permit stepless voltage adjustment with low voltage drop.—The Superior Electric Co

Recorder mounts like meter

8 • Miniature circular-chart unit records any electrical signal. 3¾ x 3¾ x 3 in. deep, it may be panel-mounted or mounted in a meter enclosure for outdoor use. As a demand meter it checks regulator loads and 3-phase load balance, also records line voltages. No pen, ink or ribbon are required; graph is printed by a stylus on pressure-sensitive paper. Gear shift adjusts chart rotation at three speeds. For easier reading, suppressed scales are available—Instrument Div, Thomas A Edison Industries

Deaerator protects piping

9 • Hot-water deaerator keeps temperature below scalding. Steam deaerator is operated at a partial vacuum using an ejector which removes corrosive gases and produces required operating vacuum. Resulting water is used at about 132 F—below the scalding point. Deaerator of this design can produce any water temperature depending on operating-steam pressure. — Permutit Div, Pfaudler Permutit Inc

Joints keep friction down

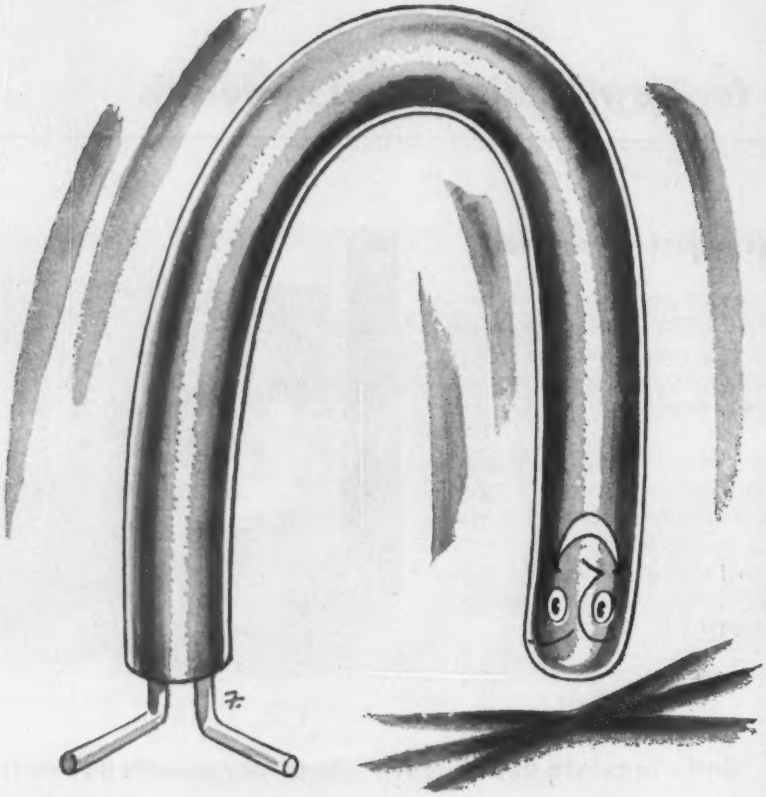
10 • Bellows expansion joints, rigid against all but axial movement, are externally or internally guided. When internal, guide ring welded to inner slip rides along machined bore of the body. When guide is external, surfaces move in bore of external guide. Surfaces are finished to close tolerances, holding friction to a minimum and cutting danger of pipe strain.—Adsco Div, Yuba Consolidated Industries, Inc

Hose works under pressure

11 • Hose is designed to handle steam under pressure, resists temperatures to 300 F, pressures to 125 psi. Neoprene jacket makes it tough, yet flexible and crimp-resistant. Teflon inner tube has low-friction coefficient and is inert to corrosive materials, according to manufacturer.

The hose is easily cut to desired lengths, may be used with standard tube fittings. Sizes: from ¼- to ½-in. ID.—W S Shamban & Co

For more data on these developments, circle key numbers on Reader Service card, p 109



Ceramo®* Thermocouples will bend over backwards to fit your job!

All of us "Ceramo*-Couples" can bend to almost any configuration, and we don't break our skins, or lose insulation either! When they put us together, they did the job "right."

Over ten years ago, Thermo Electric invented us. Since then, we've multiplied to so many types and sizes that we can do almost any job — and do it better too! We measure temperatures from minus 450°F to 4000°F and higher. Pressures up to 50,000 psi. don't bother us either. We're rugged! We always give you accurate, fast, sensitive and stable temperature readings.

Find out about our whole family —

WRITE TODAY FOR YOUR THERMOCOUPLE CATALOG TC - 42

More than 48 pages of profitable information on every type of Thermo Electric Thermocouples.

Thermo Electric

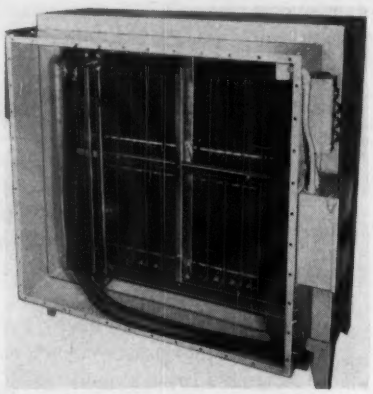
*Ceramo® — Thermo Electric's ceramic insulated, metal sheathed thermocouple wire.

THERMO ELECTRIC Co., Inc., Saddle Brook, New Jersey
In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

20 YEARS • *Temperature Measuring Systems and Components*

Equipment news

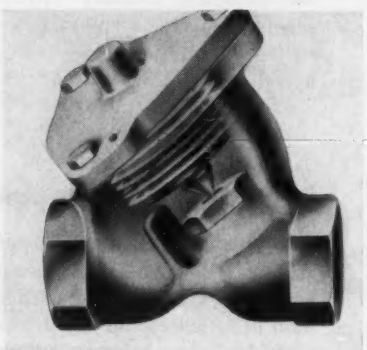
Begins on page 124



Packaged precipitator

68 • Completely self-contained, this high-velocity electrostatic precipitator is designed for use in inaccessible areas or with air-handling units. It comes complete with front and back duct connections, drain pan and preassembled washing and oiling mechanism. You have your choice of 24 sizes from 1000 to 25,000 cfm, floor- or ceiling-mounted.—American Air Filter Company, Inc

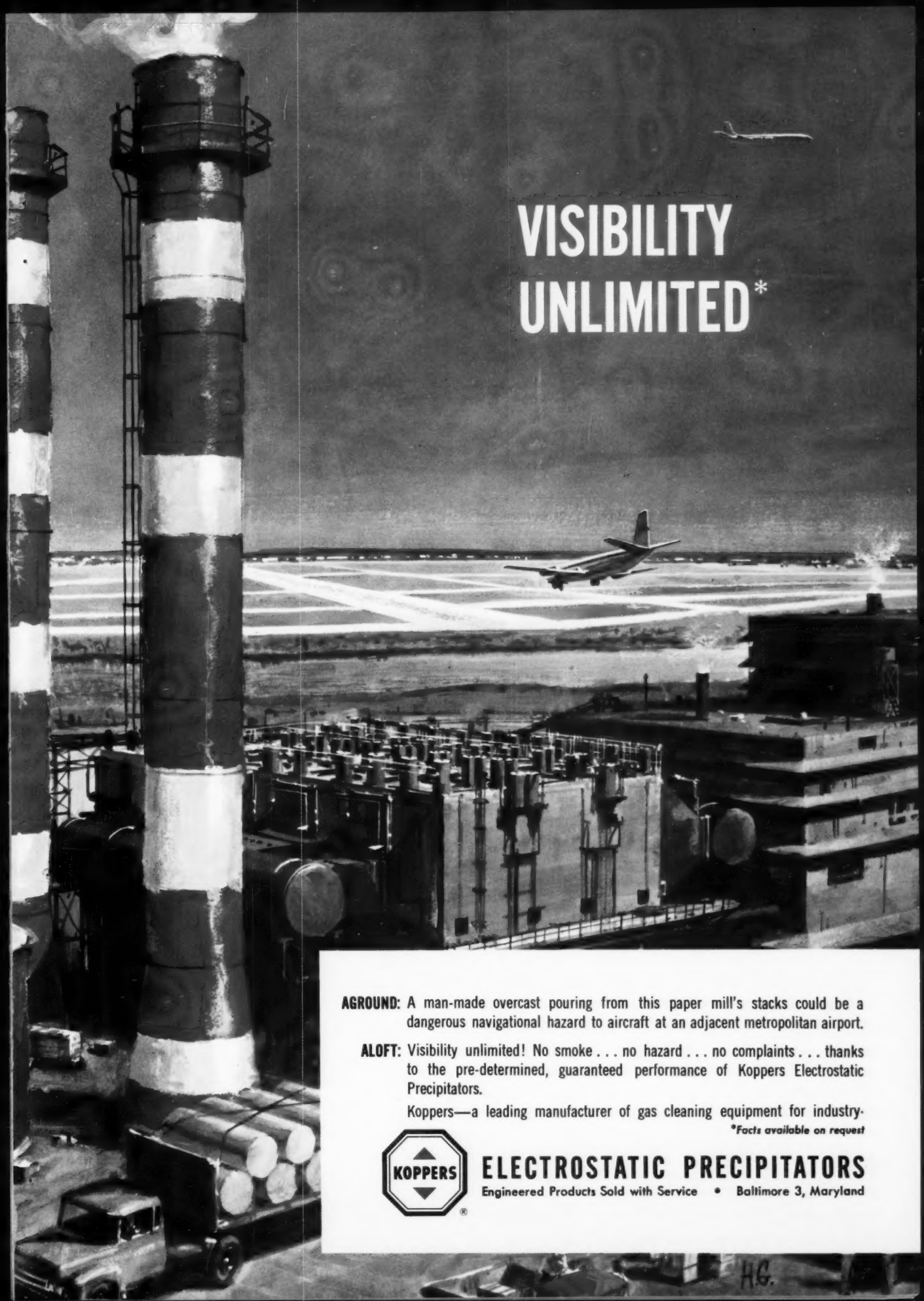
Just circle key numbers on the Reader Service card, page 109, to get complete product story



Thermostatic trap keeps live steam in

53 • Rugged trap comes in ½- and ¾-in. sizes, operates on true-balanced pressure principle. Designed for pressures from vacuum to 150 psig, temperatures to 425 F, it's suited for duties in tracer lines and small pieces of steam-processing equipment.

continued on p 130



AGROUND: A man-made overcast pouring from this paper mill's stacks could be a dangerous navigational hazard to aircraft at an adjacent metropolitan airport.

ALOFT: Visibility unlimited! No smoke . . . no hazard . . . no complaints . . . thanks to the pre-determined, guaranteed performance of Koppers Electrostatic Precipitators.

Koppers—a leading manufacturer of gas cleaning equipment for industry.

**Facts available on request*

KOPPERS®

ELECTROSTATIC PRECIPITATORS

Engineered Products Sold with Service • Baltimore 3, Maryland

HIGH-PRESSURE JETS BLAST DEPOSIT-PACKED BUNDLES CLEAN AS NEW

The high-pressure jet unit below is blasting solidly-caked deposits from a heat exchange bundle . . . removing substantially all traces of deposits throughout the bundle, without cutting it apart!

Nation-wide Dow Industrial Service developed this automatic unit to remove scale, coke and asphalt deposits without metal erosion or wall thinning. This is just one of many advanced tools and techniques developed by Dow Industrial Service to clean equipment of every kind... boilers, pipelines, chemical process equipment, towers, scrubbers.

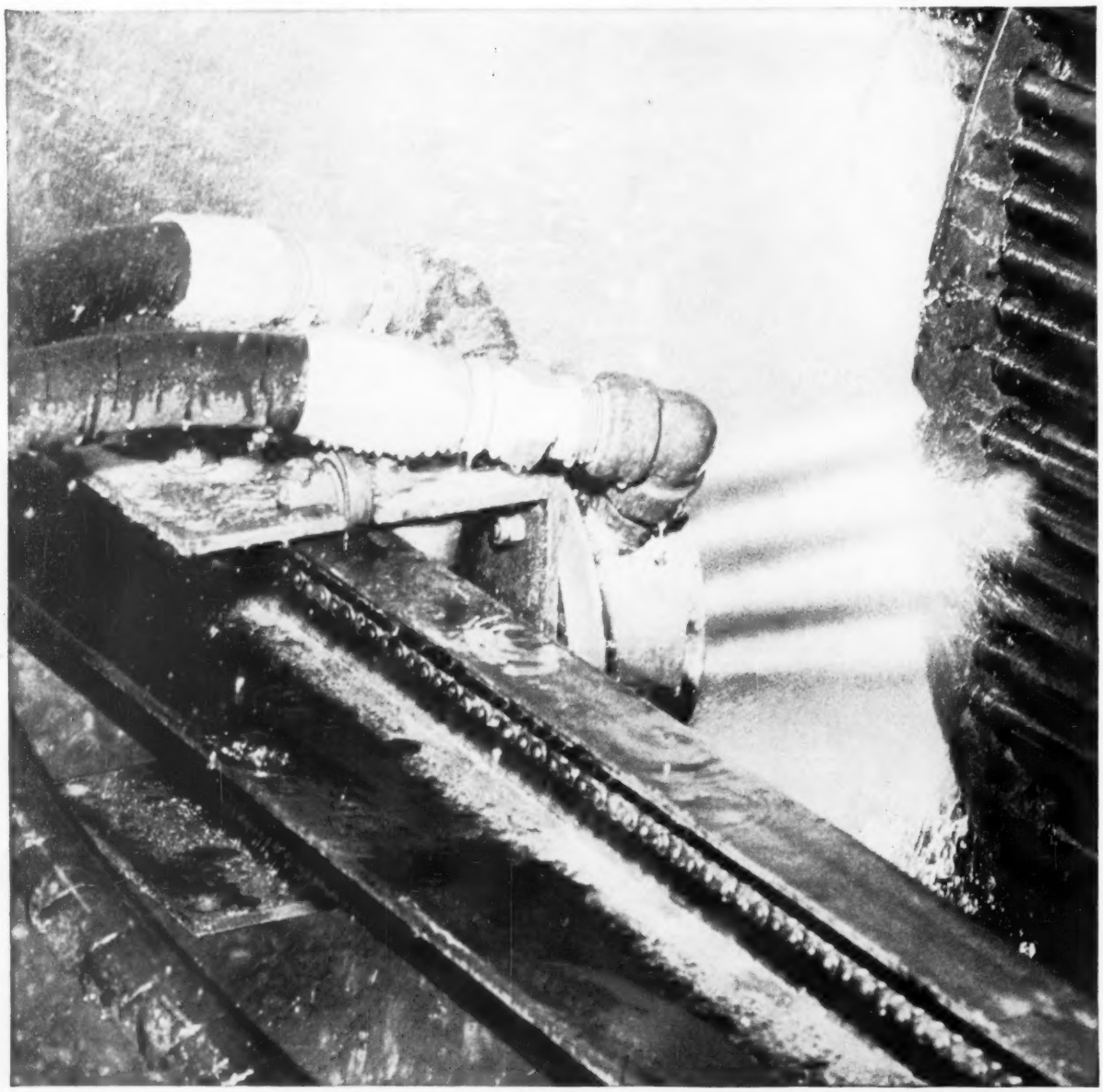
D. I. S. engineers first analyze your problem, then pick the most effective cleaning method . . . whether chemicals, steam, jet, foam, or other means. D. I. S. tailors the technique to give you most value per dollar.

In addition, D. I. S. offers complete consulting laboratory service for water treatment and waste processing problems, backed by the technical resources of The Dow Chemical Company.

D. I. S. is a nation-wide industrial service . . . and offers "total" cleaning. For cleaning equipment of *any* kind, *anywhere*, call D. I. S. We'll be glad to show you how to set up a year 'round cleaning program to *keep* equipment operating at top efficiency. Write or call DOW INDUSTRIAL SERVICE, 20575 Center Ridge Road, Cleveland 16, Ohio. Dept. P9.

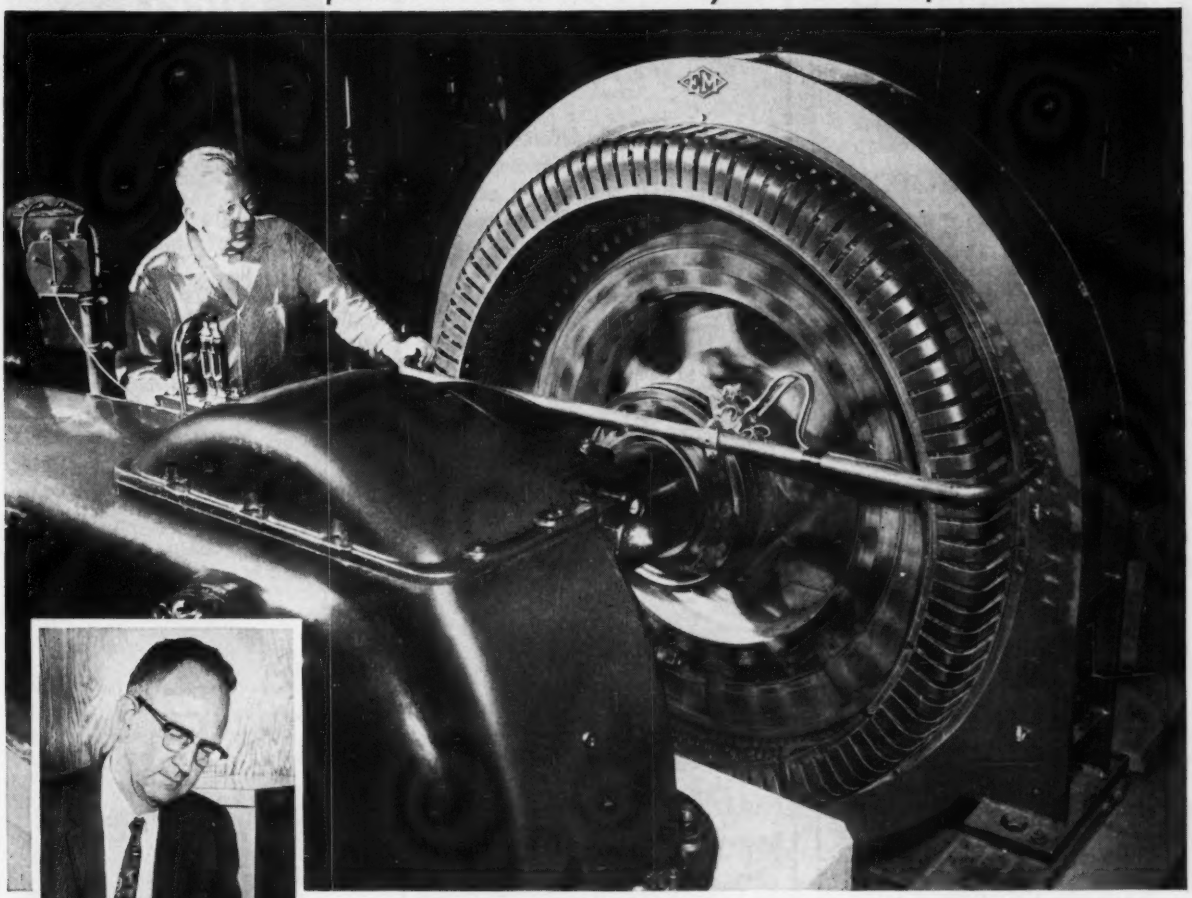
DOW

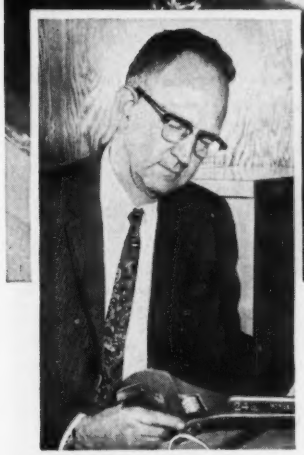
DOW INDUSTRIAL SERVICE • Division of The Dow Chemical Company



Automatic jet unit removes bundle deposits, without dismantling.

E-M Motor starts equivalent of second 50 years of compressor service!





After running approximately 108,000 hours, this E-M Synchronous Motor is still on compressor duty at Diamond Tool and Horseshoe Co. Contributing to the remarkably long life of the motor was the careful attention of Mr. J. Gordon Mitchell (above), Diamond Tool's electrical maintenance man. The motor is rated 350 hp, 200 rpm, 1.0 PF, 440 volts.

Mr. Hampton Connell, Vice President, Engineering, of Diamond Tool and Horseshoe Co. His company recently celebrated its 50th Anniversary as a manufacturer of hand tools and drop forgings.

"We just can't seem to wear them out!"

Diamond Tool and Horseshoe Co. of Duluth, Minnesota has an E-M Motor on compressor drive that has been running for the equivalent of *40 hours a week for over 50 years—approximately 108,000 hours!* Yet this same motor is still in service 16 hours a day.

Mr. Hampton Connell of Diamond Tool tells this unsolicited story about his untiring E-M Motor:

"This particular motor was installed about 1942, and was in service 24 hours a day, 7 days a week during the last war. Following the war we operated this unit 24 hours a day, 5 days a week for a considerable period of time. For the past several years we have been running the machine 16 hours a day, 5 days a week.

"We have been using E-M Motors in our factory on our air compressors for a good many years now, and with very satisfactory results."

E-M Motors have earned a reputation for reliability and endurance in many industries. Get more information about them. Call your nearby E-M Sales Engineer and write the factory for free Compressor Number of E-M Synchronizer 52.

ELECTRIC MACHINERY MFG. COMPANY

MINNEAPOLIS 13, MINNESOTA

E-M

1200-TPA-2214

***Specialists in making motors do* EXACTLY WHAT YOU WANT THEM TO**

ILLCO-WAY
ion Xchange

FIELD REPORT

COUNTERFLOW*

REGENERATION

THIS PATENTED METHOD PROVIDES MORE EFFICIENT OPERATION OF ION-EXCHANGE EQUIPMENT.

Conventionally, in ion-exchange equipment used for chemical processes, the resin bed is exhausted, or "loaded," by a downward flow of liquid and then regenerated, or "stripped," by a *downward* flow of acid or alkali.

As a result, the lower part of the resin bed is inadequately regenerated, unless a great excess of regenerant is used. Then, during the service cycle, the impurities thus left near the bottom of the resin bed will be leached off into the product. Or, if the resin is used to pick up valuable materials, an incomplete separation will occur.

The logical solution would be *up-flow* regeneration, but normally, due to the low density of ion-exchange resins, the bed would rise or expand and there would be insufficient contact of regenerant. With COUNTERFLOW*, however, Illinois Water Treatment Company has achieved successful *up-flow* regeneration by introducing a "barrier" to prevent bed expansion. For example, one method is to introduce water at the top and regenerant at the bottom, drawing both off just above the resin bed.

Substantial improvements result from COUNTERFLOW*—resin capacity increased as much as 25%, leakage of impurities reduced as much as 75%. Where the resin is used to pick up valuable materials, COUNTERFLOW* "stripping" gives more complete separation without increased dilution.

*COUNTERFLOW *is the trademark of Illinois Water Treatment Company equipment utilizing an up-flow method of regeneration with a "barrier" to keep the bed from expanding. U.S. Patent No. 2,891,007.*

For detailed information, address:

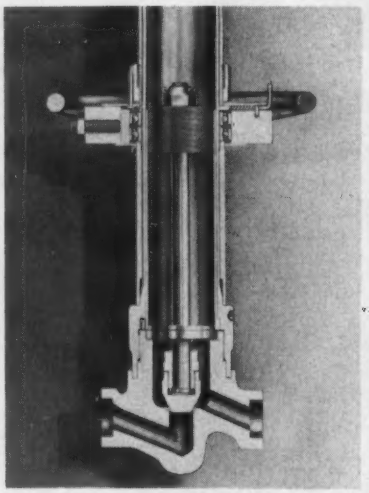
ILLINOIS WATER TREATMENT CO.
840 CEDAR ST., ROCKFORD, ILLINOIS
NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Can.

circle 276 on Reader Service card, p 109

Equipment news

Begins on page 124

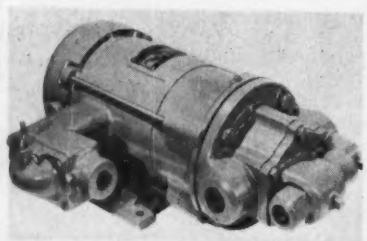
Steam-saving baffle deflects live steam upward to envelop the monel bellows, providing fast snap-closed action.—W H Nicholson and Company



Nuclear globe valves boast zero leakage

52 • Hermetically sealed globes work at high temperatures—600 F at 2200 psi is their normal rating on pressurized-water reactors. They're being field-tested handling radioactive chemicals, h-t gases, light and heavy water. The ½- to 2-in. valves permit instantaneous changes in setting. Their mechanical advantage is high, maker states.—United Shoe Machinery Corporation

Just circle key numbers on the Reader Service card, page 109, to get complete product story



Motor-mounted rotary pump handles clean liquids, solvents

54 • Pump and motor are integral; motor bearings support their com-

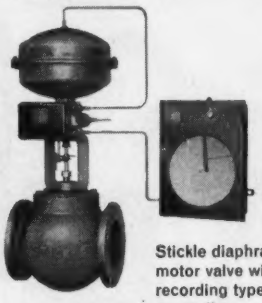
STICKLE
Diaphragm Motor Valves and Controllers

For Controlling the Pressure or Temperature of Steam or Liquids

Stickle diaphragm motor valves with recording or indicating type controllers automatically maintain any desired pressure or temperature of steam or liquids. Models are available in three classes to meet various pressure and service requirements, as follows:

CLASS	PRESSURE	SIZES
50	To 50 psi	½" to 14"
125	To 125 psi	½" to 8"
250	To 250 psi	½" to 6"

Each model offers a wide choice of inner design, trim, and accessories. This means better performance at minimum cost, because you get the best valve for each job—at the low standard price.



Stickle diaphragm motor valve with recording type controller

The Stickle valve-controller systems shown here—above and below—operate with an accuracy of plus or minus 1% of the instrument's total span. The recording type controller above, has an automatic valve position to insure positive and accurate valve travel, and 24-hour chart with one or two pens. The indicating type controller is shown below.

Stickle diaphragm motor valve with indicating type controller

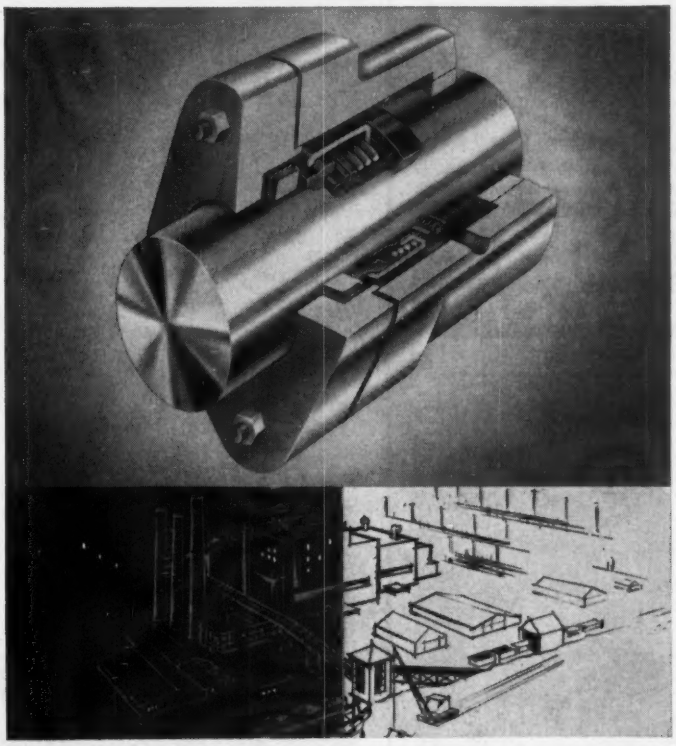
For Prices and Complete Data Request Stickle Bulletin No. 335

STICKLE STEAM SPECIALTIES CO.
2265 Valley Ave. • Indianapolis 18, Ind.

circle 277 on Reader Service card, p 109

ENGINEERED PRODUCTS

for Plant Maintenance



Garlock PK MECHANIPAK Seals work night and day to stop leakage, reduce downtime, and cut maintenance costs on centrifugal pumps and similar equipment.

For 'round the clock prevention of leakage on rotary shafts, apply Garlock PK MECHANIPAK* Seals.

Specified as standard by many industrial companies and utilities, Garlock PK MECHANIPAK Mechanical Seals also help protect equipment from failure in many high temperature applications.

Plant engineers and maintenance personnel enjoy the ease with which Garlock PK MECHANIPAK Seals are handled and installed. A self-contained "package" unit, the seal has no parts that must be put together. The rotating portion simply slides onto the shaft; the stationary portion positions quickly into the counterbore of the gland. Once the Garlock PK MECHANIPAK is installed, further adjustment is unnecessary. No parts of the seal move on the shaft or sleeve, eliminating wear to these parts. A spring in the seal maintains contact between sealing faces, thus assures leak-proof operation.

To meet the various application conditions encountered on centrifugal pumps and similar equipment, Garlock PK MECHANIPAK Seals will operate at pressures to 150 p.s.i., and in temperatures as high as 212° F with Buna-N bellows . . . above 212° F with fluid at faces and Viton† bellows. The standard seals can be applied on shafts from ⅜″ to 3″ in diameter, with speeds up to 2000 f.p.m. and are available for "off-the-shelf" delivery. Garlock PK MECHANIPAK Seals will work effectively against water, oils, alcohol, mild acids and solvents. Where application conditions are more extreme (i.e., higher temperatures, shaft speeds, or pressures) Garlock PK MECHANIPAK Seals are available in several different materials, each suited to a particular requirement.

For the complete story, get in touch with the Garlock representative in your area. Call him at the nearest of the 26 Garlock sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalog AD-150, Garlock Inc., Palmyra, N.Y.

GARLOCK

Canadian Division: Garlock of Canada Ltd.

Plastics Division: United States Gasket Company.

Order from the Garlock 2,000 . . . two thousand different types of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

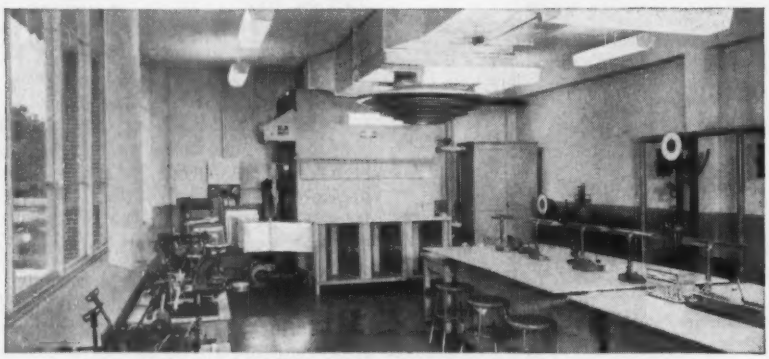
*Registered Trademark
†DuPont Trademark

For more facts circle 278 on Reader Service card, p 109

Replacement Tubes

BOILER TUBE
COMPANY OF AMERICA
McKEES ROCKS, PA. (Pittsburgh District) Federal 1-7750

For more facts circle 279 on Reader Service card, p 109



AIR CONDITIONING THAT KEEPS ITS PROMISE OF PRECISION

NIAGARA Type "A" air conditioners assure that you actually realize all the benefits of precise atmospheric conditioning in your testing laboratory, your "clean room" or in your processing of hygroscopic materials.

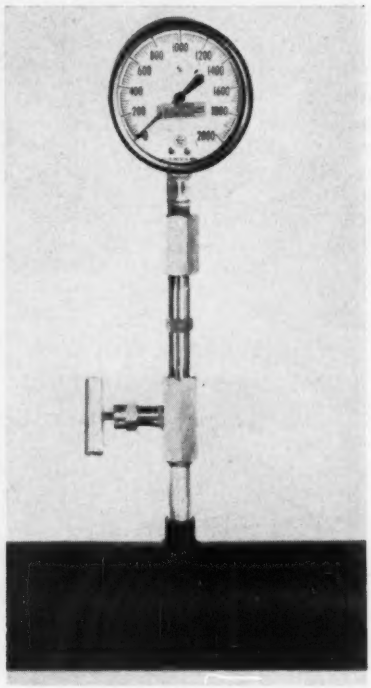
This assurance; temperatures controlled to a fraction of a degree, relative humidity held to within 1%, results because this unit, exclusively, can provide saturated air in such compact space. Its extra capacity absorbs sudden peak loads. You hold your standard conditions continuously, without interruption. With its simple, inexpensive control you can vary your standard at will and reach the new condition quickly. Its range, using the Niagara "No-Frost"® liquid below the freezing point of water, is through 140° F. It's reliability is proven. Service records show many machines still precise in operation after 20 years' service.

Write for Bulletin 58 and 122

NIAGARA BLOWER COMPANY
Dept. P-9, 405 Lexington Ave., New York 17, N. Y.
District Engineers in Principal Cities

mon heavy-duty shaft, offering economy and easy installation. Delivery rates run from 10 to 30 gpm, pressures up to 125 psig, viscosities to 5000 ssu. Special mechanical seal in pump cylinder needs no adjustment; a weep hole between seal and motor flange signals seal failure.—Blackmer Pump Company

Just circle key numbers on the Reader Service card, page 109, to get complete product story

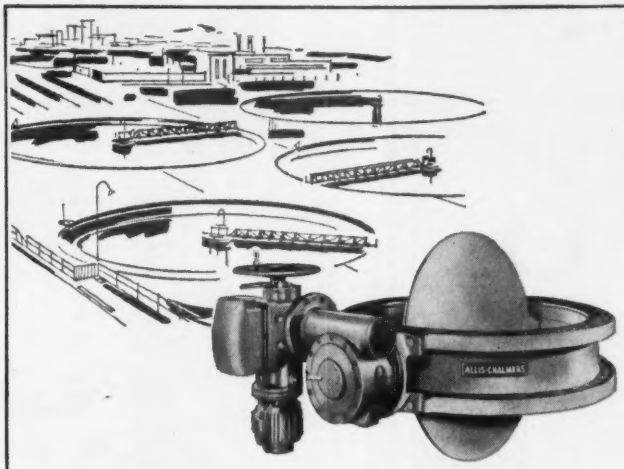


Valve-siphon assembly mounts h-t steam gages

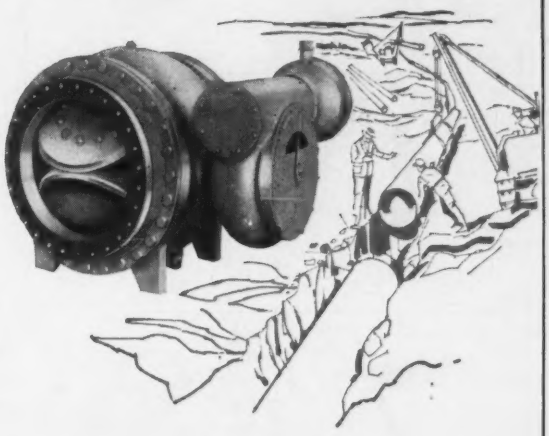
67 • Siphon assembly is made of bar stock for strength. An integral trap forms a condensate seal between gage and high-temperature steam or process fluid. Barrel is stainless steel for low heat transfer. One feature: you don't have to throw away the siphon if it becomes plugged — straight-through design means you can clean it by running a rod down its central passage. — Anderson, Greenwood & Company

continued

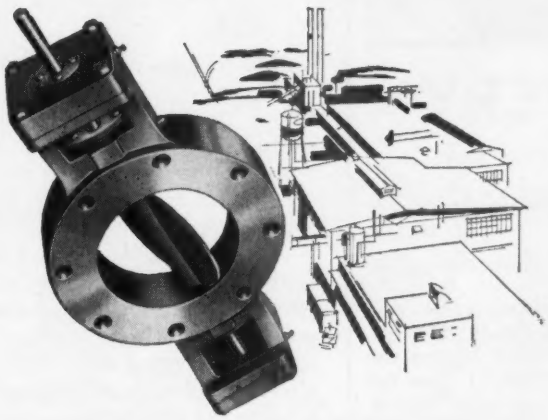
ALLIS-CHALMERS



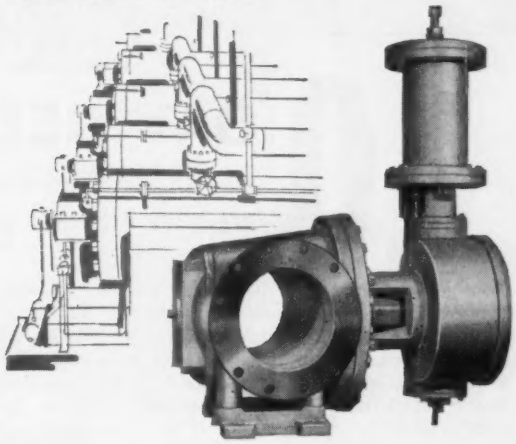
BUTTERFLY VALVES — For liquids or gases — uniform control in all positions, fast positive regulation and closure, minimum pressure drop. Compact and lightweight. Sizes from 1 in.



BALL VALVES — Easy manual shutoff under adverse conditions, and up to 150 psi. Slight wedging action gives unusually drop-tight closure. Sizes: 12 to 48 in.



WAFER VALVES — A new design of butterfly valves with space-saving flexibility, suited to most any type of operation. Sizes from 3 to 36 in., including high-pressure types.



ROTOVALVE—A cone valve suited to virtually any type of operation or location. Offers the least pressure loss, greatest initial shutoff, controlled closing time, positive seating.

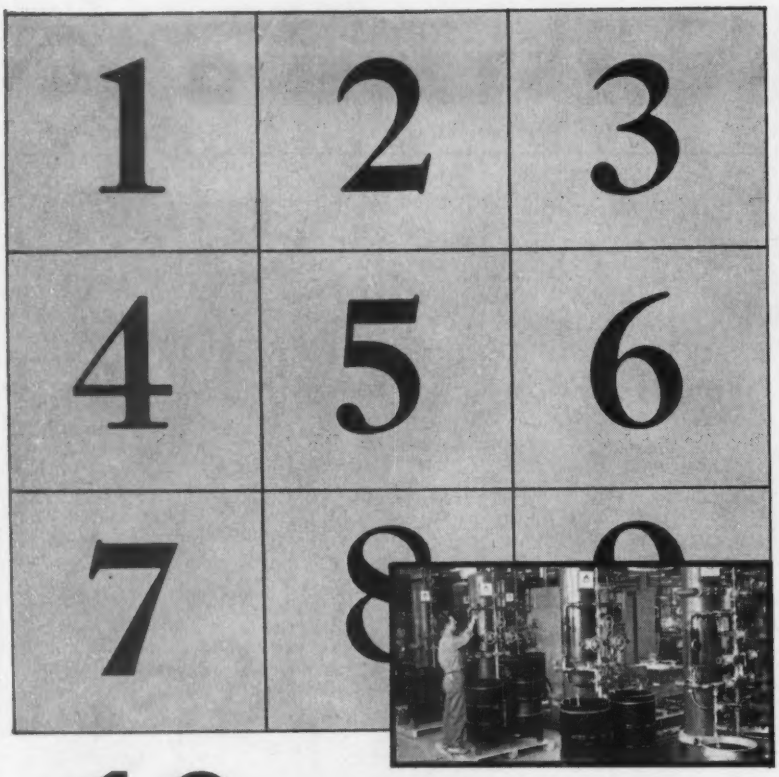
Now: for power plants, sewage and water works —

a full line of rotary valves

Serving you even better through a broader line—Allis-Chalmers offers the finest in butterfly, ball and cone valves for industrial applications, power plants, sewage and water works. Also available are complete valving systems in standardized "packages" that provide *remote, telemetered control of valve operation.* These additions further round out Allis-Chalmers line that includes Angle, Needle, Relief valves, sleeve-type valves and accumulator systems. *For details, contact your Allis-Chalmers valve representative or write* **Allis-Chalmers,** *Milwaukee 1, Wisconsin.* Rotovalve is an Allis-Chalmers trademark.

A-1381

For more facts circle 281 on Reader Service card, p 109



10 DAY DELIVERY

ON PERMUTIT BD SOFTENERS AND STANDARD PACKAGED DEMINERALIZERS

Now you can order "off-the-shelf" delivery of these Permutit units—a complete line of economy water softeners and packaged demineralizers. They're in stock now—ready for immediate delivery within ten days after we get your order:

Model BD Softeners: This complete line of Permutit units takes advantage of standardized mass-produced components and a new design, to radically cut the cost of industrial water softening. Shipped in component kit form for easy assembly and fast installation. Available in these sizes and capacities:

Shell Diam.	Straight Height	Flow Rate Average	Softening Capacity
30″	6′	40 gpm	510 kgr
36″	6′	56 gpm	750 kgr
42″	6′	77 gpm	1020 kgr
48″	6′	100 gpm	1380 kgr

Standard Packaged Demineralizers: Permutit's skid-mounted, mixed-bed units require no field assembly, no delays, no capital tied up in construction. Each is pretested and factory-guaranteed. Just make the plumbing and electrical connections and put the unit to work.

Now available on ten-day delivery are the 12″, 15″, 20″ and 24″ sizes, giving you flow rates up to 20 gpm (50 gpm for polishing). All of them can produce demineralized water averaging over 6,000,000 ohms specific resistance, or about 0.05 ppm dissolved solid content.

A small size mixed-bed demineralizer, model MBD-6A, can also be delivered from stock.

Also available for fast delivery: Other types of demineralizers, and fully packaged water treatment systems providing flow rates up to 50 gpm, can be quickly assembled from Permutit's standardized components and shipped to you on accelerated delivery schedules.

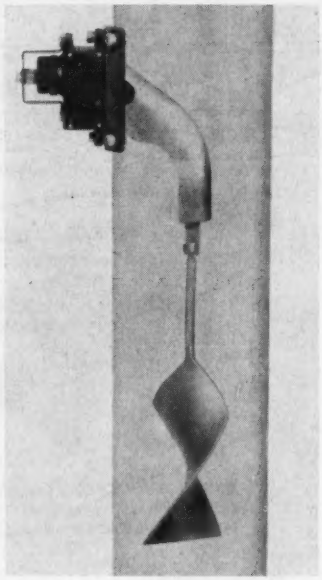
For further details on any of these products, write, wire or call our Permutit Division, Dept. PO-91, 50 West 44th St., New York 36, N. Y. (OXford 7-6600). (In Canada, contact the Permutit Company of Canada, Toronto.)

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes

Equipment news

Begins on page 124



Solids flowmeter

64 • Total flow of granular material —coal, ore—can be measured in vertical ducts, spouts or pipes with diameters up to 40 in. A helical quarter-turn vane converts velocity into rotational speed to operate a direct mechanical counter or a remote counter. Spacers in the meter make sure vane is always centered for accuracy. There's a constant air flow (less than 0.1 scfm at 5-psig supply) to purge any dirt that may work into the bearings.—Bailey Meter Company

Just circle key numbers on the Reader Service card, page 109, to get complete product story

Tube-to-hose fitting needs no adapter

28 • This fitting lets you join tube directly to one end of a hose assembly. Since it has a separate grip and seal, the fitting needs no female swivel, threading, flaring or soldering. You can get it to fit single- or double-wire-braid hose, in hose sizes from 3/16- to 1½-in. ID, tube OD's from ¼ to 1½ in.—The Lenz Co

continued

This compact Package Air Preheater is being installed on a 150,000 lb/hr boiler at Olin Mathieson Chemical Corp.'s Brandenburg, Kentucky, petrochemical plant. When in operation it will recover enough heat from the boiler exhaust to increase efficiency of the boiler between 8% and 9%.

OLIN MATHIESON RECOVERS 360°F FROM BOILER EXHAUST WITH 11½′ x 11′ x 8′ PREASSEMBLED LJUNGSTROM® PACKAGE AIR PREHEATER

Olin Mathieson specified a Ljungstrom Package Air Preheater because it saves space as well as fuel. Mathieson's Ljungstrom occupies only about 1000 cubic feet, but cuts boiler exhaust temperature from 680°F to 320°F — puts 360° of heat back to work in the boiler.

The compact preassembled Package Air Preheater is ready to run when it's delivered—just connect to the power line and ducts, and it's on-stream. You make big savings on installation because there's no on-the-spot erection.

You can use a Ljungstrom Package Air Preheater on boilers from 25,000 to 250,000 pounds of steam per hour. For more information, write today for your free copy of a 14-page booklet.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

For more facts circle 283 on Reader Service card, p 109

THE MOST COMPLETE LINE OF MECHANICAL PACKINGS* IS EASIEST TO GET FROM INDUSTRIAL DISTRIBUTORS EVERYWHERE

(See Thomas' Register and Conover-Mast Purchasing Dir.)

*HIGH PRESSURE ASBESTOS • ROTARY PUMP PACKINGS • VALVE PACKINGS • V-RINGS • LEATHER PACKINGS • SHEET PACKINGS AND GASKETS • HYDRAULIC & PNEUMATIC PACKINGS • METALLIC PACKINGS • PLASTIC PACKINGS • TEFLON PACKINGS & GASKETS • SPIRAL WOUND GASKETS

Better Buy BELMONT

THE BELMONT PACKING & RUBBER COMPANY • PHILADELPHIA 37, PA.

Equipment news

Begins on page 124

Portable sump pump

51 • Self-contained pneumatic sump pump needs no priming to handle sewage, sludge, chemicals, oil or water. Body, impeller and strainer are bronze. They resist corrosion and also provide sparkless operation, pumping inflammable or explosive liquids safely, according to the manufacturer. Pump stands 19⅜-in. high, fits through a 10 x 12-in. hole. Speeds: 3200 to 3600 rpm, depending on head and air pressure.—Schramm, Inc

Just circle key numbers on the Reader Service card, page 109, to get complete product story

Lancing powder now comes as uniformly sized mixture

58 • Uniformly sized, intimately mixed powder carries heat from flame to cut without heat loss, maker claims. Powder is made up of iron and aluminum particles from 0.01- to 0.05-mm diameter, blended and mixed for efficiency and protection against lance burnout. It's available ready-mixed in 100-lb drums.—Linde Company

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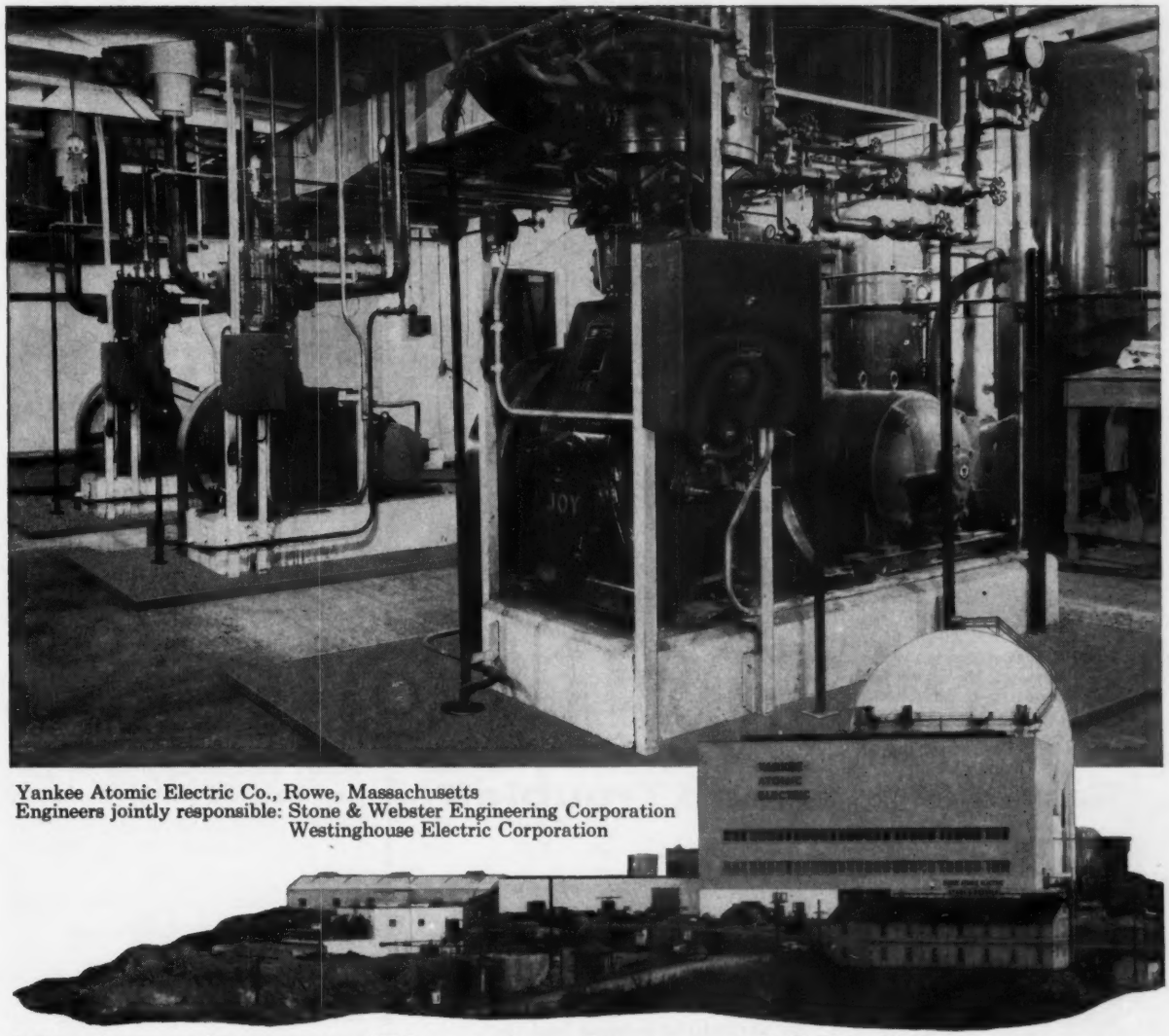

Yankee Atomic Electric Co., Rowe, Massachusetts
Engineers jointly responsible: Stone & Webster Engineering Corporation
Westinghouse Electric Corporation

Yankee Atomic Electric chooses JOY Compressors for New England's first Nuclear Power Plant

Compressed air requirements at the Yankee Atomic Electric plant are not large but vitally important. Reliability of all machinery is a must, once the reactor goes critical. Two Joy WGO-9 vertical compressors supply oil-free air for instruments and controls. Each machine produces 172 cfm at 100 psi and is V-belt driven by a 25 horsepower motor. Carbon graphite piston rings completely eliminate lubricating oil in the cylinders. The compact vertical design requires less than seven square feet of floor space for each installation.

General service air is supplied by a 100 hp Joy WG-9H compressor producing 769 cfm at 100 psi. This machine has the same space-saving vertical design in sizes up to 150 hp.

Joy compressors are chosen for many of the country's finest installations . . . there is a size and type for you, reciprocating, centrifugal or axial. For information, write for bulletin 1685-16.

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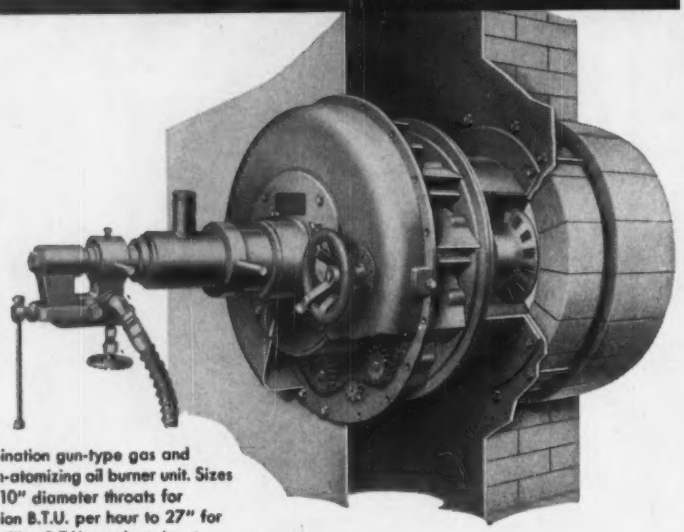
For more facts circle 285 on Reader Service card, p 109

ENCO

TYPE E OIL BURNER UNIT



Combination gun-type gas and steam-atomizing oil burner unit. Sizes from 10" diameter throats for 7 million B.T.U. per hour to 27" for 100 million B.T.U. per hour input.

Saves Money and Troubles IN 5 WAYS

1. Vanes can't stick—Easily adjusted

Air register vanes are easily adjusted by a single hand wheel for either clockwise or counter-clockwise air rotation. The action is without stiffness or sticking. Vane shafts are stainless steel — heat-resistant, corrosion-proof — turn smoothly in carbon graphite bearings at all operating temperatures.

2. Positive Vane Control —no lost motion

Chain-and-sprocket air-vane control, with take-up adjustments, assures easy and precise setting at all times. There are no links to wear and wobble with a flopping action of the vanes when they pass dead center.

3. Adaptable to oil or gas —or both

Changeover from oil to gas or a combination of both can be done easily — with comparatively low cost standardized parts—to get the full advantage of variations in fuel prices.

4. For wide range or standard range burners

Registers accommodate standard range or wide range oil burners — mechanical or steam atomizing — and gun type or ring type gas burners—the one best type or combination for your individual needs.

5. Adaptable to all housing designs

Extra deep burner housing can be used to suit practically any fan and any duct arrangement — with lowest installation cost — and provide proper air distribution for efficient combustion.

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EC613

THE ENGINEER COMPANY

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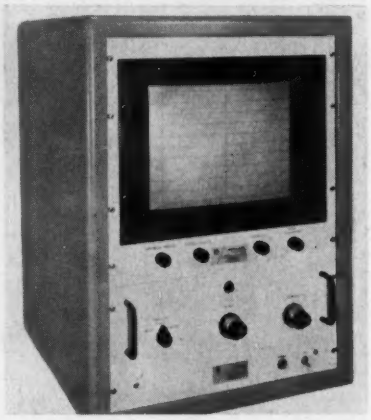
Equipment news

Begins on page 124



Bar-graph oscilloscope displays 48 inputs

60 • Instrument displays any phenomena that can be measured by an electrical output, according to its maker. Typical: temperature, pressure, strain and velocity. Model 220 comes complete with input delta-switch commutator, selective thermocouple reference junction and input junction box. Price: $3750. — Advanced Technology Laboratories

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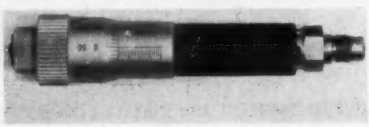
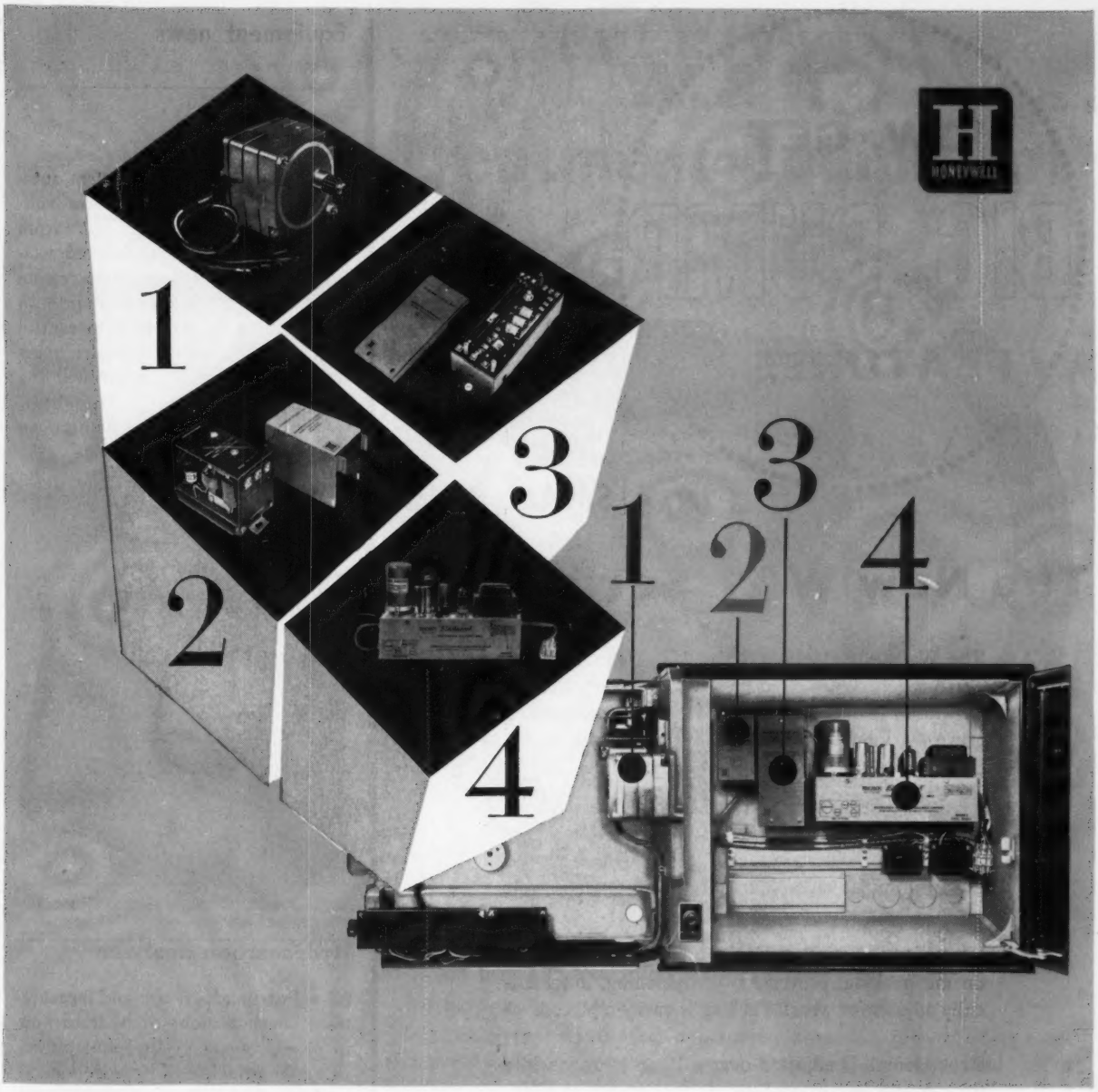


Pocket-sized gage measures peak cylinder pressures

65 • Self-contained mechanical indicator measures peak compression and combustion pressures in high-speed diesel engines. A micrometer type scale graduates from 0 to 2000 psi in increments of two.—Kistler Instrument Corporation

Data system for electric-power utilities

62 • Modular building-block design and standard components of this data-alarm system promise reliability and



It's what's in the modules that matters!

Take the newly designed modules in ElectroniK 15 Potentiometers. These modules have operating and servicing features that represent the very latest developments in the art of reliable instrumentation—**1.** Sectionalized motor module makes servicing a snap. Any major part of the servo or chart drive motors can be replaced in a matter of minutes. **2.** Line-powered constant voltage module provides a completely automatic d-c voltage source and replaces batteries, standard cells, and standardization mechanisms. **3.** Quick-change measuring circuit module reduces range or actuation changes to simple screwdriver operation. **4.** Quick-connect amplifier module is easily removed for servicing. Over 15 models available—for gain up to 40 x 10^6, for input impedance of 400 to 50,000 ohms.

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NOW, GET

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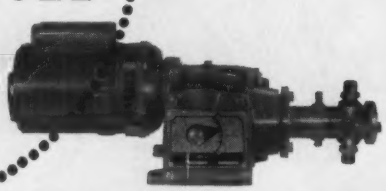
FEATURES



IN A SMALL PUMP

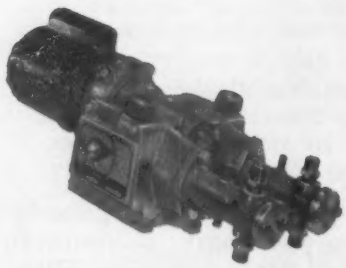
The New W&T Series 100

The Wallace & Tiernan Series 100 Metering Pump borrowed its design from W&T's Heavy Duty Pumps. Big-pump features are retained. Only size is scaled down for jobs like boiler-feed-water treatment.

The Series 100 Pump is one enclosed unit. There are no exposed moving parts. Motor and drive transmit thrust in a straight line. Pumping forces are absorbed by the heavy gear case. There are no rocker arms, no base-plate loads to twist components out of alignment.

Spring-loaded stuffing box assures proper pressure on the packing, prevents over-tightening, automatically adjusts for wear. Packing is easily replaced.

Stroke length is adjusted over a 10 to 1 range while the pump is running. Even in the double simplex, each liquid end is individually adjusted.



The Series 100 Pump delivers 3.2 gph vs 1200 psi, 50 gph vs 100 psi, repeatable within ±1%. You get big-pump performance at a small- capacity price.

For more information, write Dept. L-10.76.

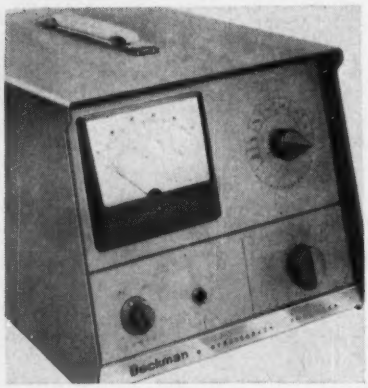
WALLACE & TIERNAN INC.

25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

Equipment news

economy, maker states. System automatically scans and measures voltages, demand, wattage, etc from potential transformers, demand meters and other instruments at remote substations. It converts the info to digital form, telemeters it to central control station where an electric typewriter records it on preprinted log sheets.

Any failure triggers a continuous alarm.—Monitor Systems, Inc



Hydrocarbon analyzer

63 • Instruments detect and measure trace concentrations of hydrocarbon in gases, vapors or the atmosphere, using the principle of hydrogen flame ionization of carbon atoms. Model 108 mounts in a panel; 109, above, is for lab or field. Either analyzer boasts full-scale sensitivity of 0 to 4 ppm carbon.—Beckman Instruments, Inc

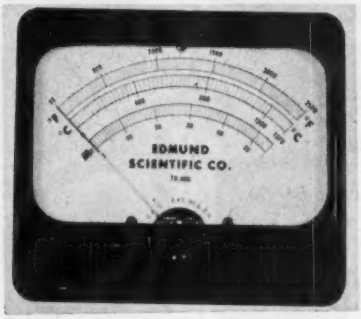
Detachable fitting can be used again

55 • High-pressure hose-assembly fitting is suitable for hydraulic and pneumatic applications on heavy automated machinery, fuel and lube systems.

These are the unit's components: (1) a tapered steel socket forms a rugged compression fitting (2) two aluminum segments grip hose reinforcement securely (3) threadless

Begins on page 124

steel nipple, available in ten different end styles, fits into hose but won't cut its inner tube.—Aeroquip Corp



Pyrometer has three scales

61 • Pyrometer can be used with most base-metal thermocouples and also does duty as a millivoltmeter in many places where pyrometers aren't usually applied. Ranges of its three scales are 32 to 2400 F, 0 to 1370 C, 0 to 50 mv. Price: $26.—Edmund Scientific Company

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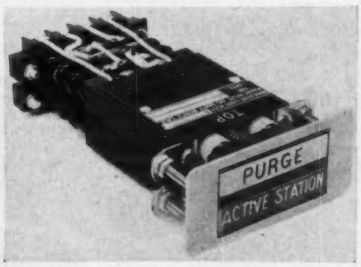
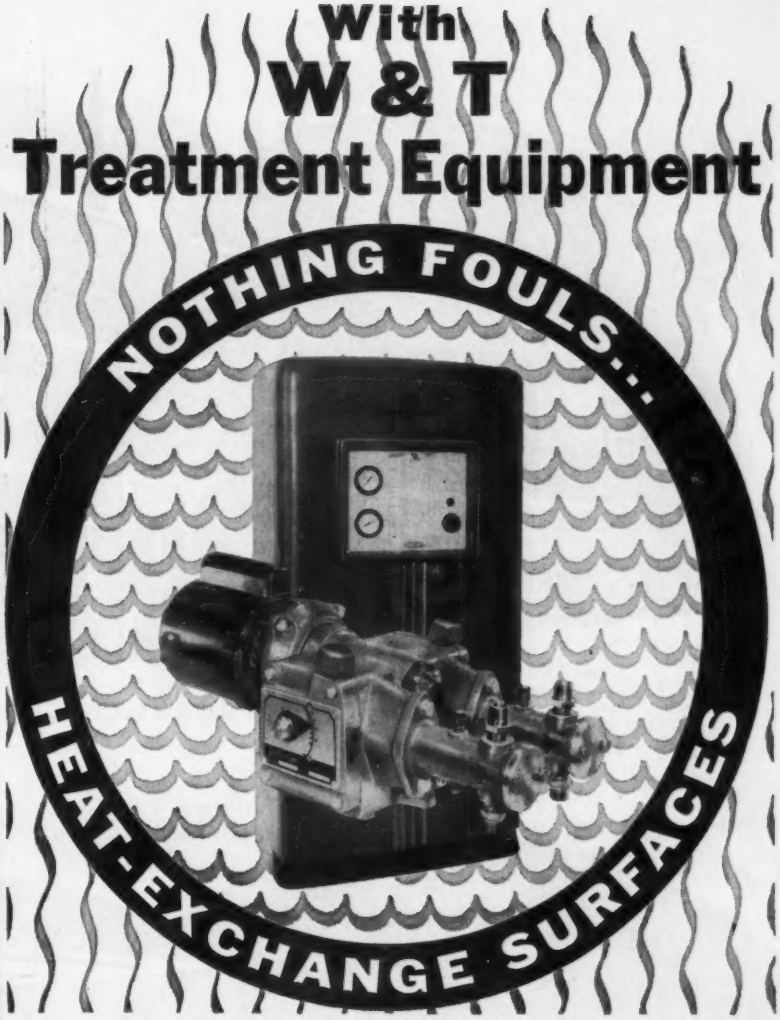


Compact indicator light

50 • Rugged, miniaturized indicator-light assembly bids for a place on the panelboards of electric-power utilities. Series R2600 comes with two replaceable or four permanent lamps —either setup gives one or two clear or colored readouts. Integral resistor banks let bulbs be energized at values higher than rated, to make a brighter signal for emergencies. Flush modular arrangements save space on crowded panels.—Radar Relay, Inc

With
W & T
Treatment Equipment



Now you can take the sting out of cooling-water contaminants, solve treatment problems with chlorinators and pumps by Wallace & Tiernan.

For biological control there's intermittent desliming.

W&T chlorination kills slime and spores, never lets growth affect heat-exchange capacity. Job-proportioned V-notch Chlorinators feed up to 8,000 lbs. of chlorine per day. Treatment is efficient and economical. You get reliable control. Heat-exchange surfaces stay slime-free.

For pH and corrosion control there's chemical feeding.

The Wallace & Tiernan Series 100 Pump feeds chromates or acids at rates of up to 50 gph or boiler-treatment chemicals against pressures up to 1200 psi. The pump's unitized construction means lifelong accuracy, reduced maintenance. Choose one or two liquid ends, with individual stroke adjustment, to double capacity or feed two chemicals simultaneously. Where high pressures are not a problem, W&T Diaphragm Pumps also give reliable feeding of 1 to 500 gpd. Heat-exchange surfaces stay corrosion-free.

With Wallace & Tiernan Chlorinators and Pumps you keep condenser tubes clean and sound, assure heat-exchange efficiency.

For more information, write Dept. S-149.76.

WALLACE & TIERNAN INC.
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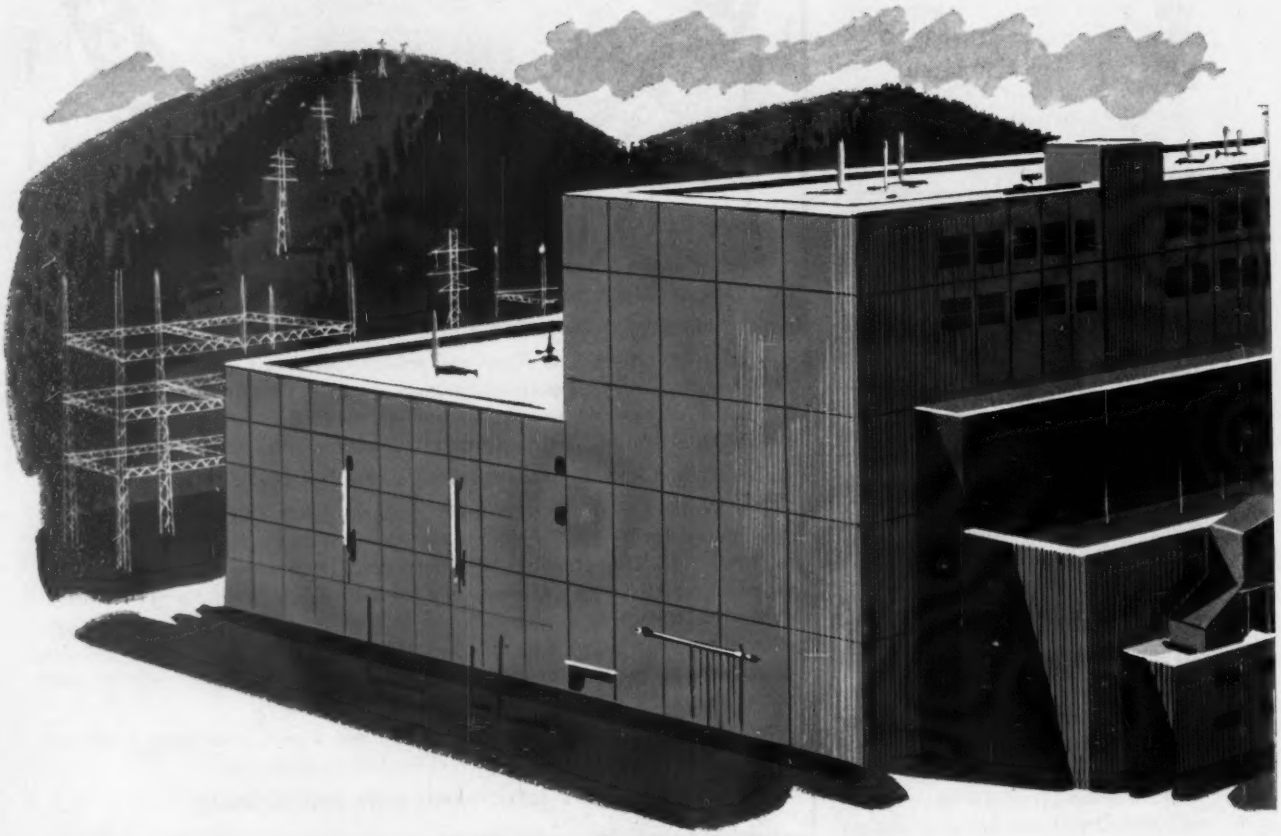

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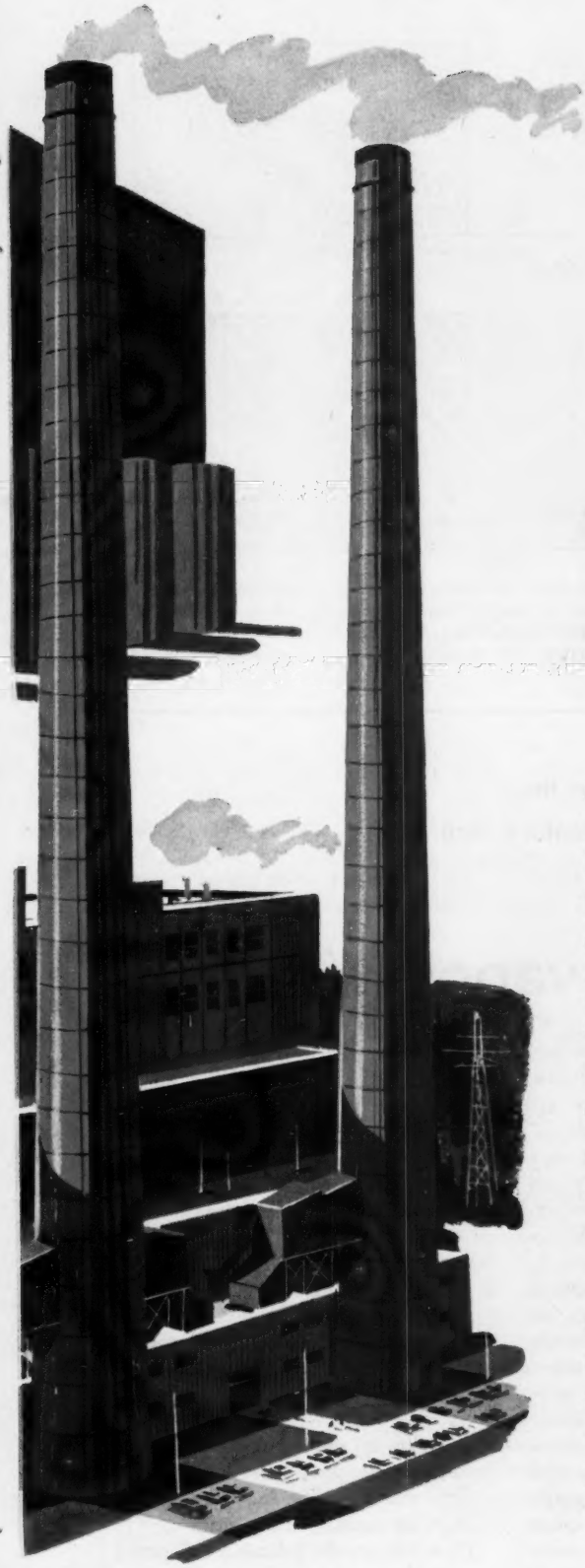

Whatever the challenge

Atomic power plants were not achieved overnight. In a large measure they were built on fundamental knowledge developed for conventional steam power plants.

Thoroughly grounded in these fundamentals, Foster Wheeler has designed, engineered and built more nuclear steam generators than any other firm in the world.

Today, nuclear-born technology at Foster Wheeler contributes directly to superior equipment of every description . . . equipment that earns a better return on plant investment.

Foster Wheeler designs and builds utility, industrial and marine steam generators; pulverized fuel systems, steam condensers, feedwater heaters, nuclear components, cooling towers, pressure vessels, oil refineries; chemical, petro-chemical and industrial processing plants. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.

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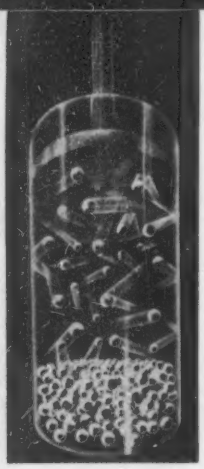
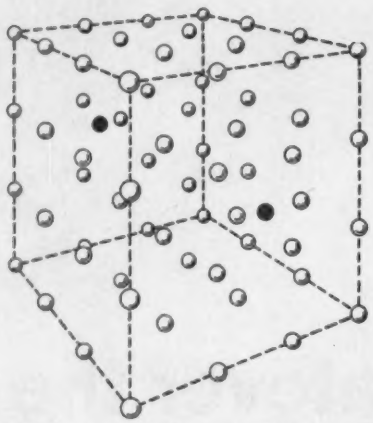
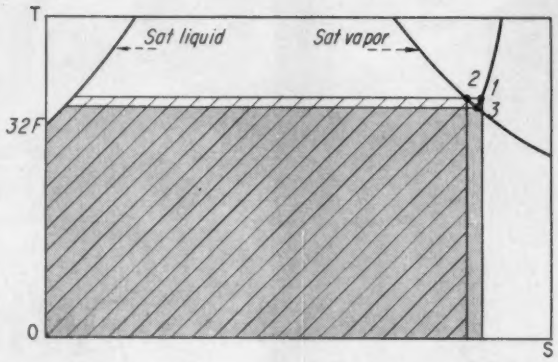


THERMO REFRESHER NO. 53



1 Here's ratio of air molecules (white balls) to vapor molecules (black balls) for highly humid air; this could be 100% humidity at about 77-F dry-bulb temp



2 Partial pressure of water vapor in air is very low at ordinary temperatures. Luckily, vapor can be figured as perfect gas. At atmospheric temperatures steam enthalpy for any level is constant whether it is saturated vapor or a superheated vapor

Man's comfort depends to an extraordinary degree on the mixture of water vapor in the air. It's only in this century that he has figured out how to measure and control it, so let us learn about...

Gas and vapor mixtures

"It's not the heat, it's the humidity," sums up the oppressive action of superheated steam in the atmosphere on mankind. Our common experience points up the variable nature of the air and steam mixture as the earth's atmosphere changes with the seasons.

Humidity measurement has been reduced to an exact science and its theory proved. Fig. 1 shows a hypothetical mixture of air (white balls) and steam (black balls). Strange as it may seem, this low ratio of vapor molecules represents a debilitating humidity—100% relative humidity at about 77-F dry-bulb temperature.

Though the steam in the atmosphere is superheated, its temperature is the same as that of the air. A glance at the Steam Tables shows that the partial pressure of the steam must be very low, well below one psia.

As preparation for this *Refresher*, it would be well to review Part 4, Nov 1956 on perfect gas laws and Part 33, Dec 1959 on gas mixtures. Important laws and equations are summarized in table, above right.

Fortunately, water vapor at very low pressures behaves essentially as a perfect gas, so we can use the perfect-gas equation, $PV = RT$. Fig. 1 shows the reason: steam molecules are so far apart that their mutual forces of attraction are negligible, so they behave like a perfect gas. This means that the steam's temperature determines its enthalpy and not the pressure, since $H_2 - H_1 = c_p\,(T_2 - T_1)$.

Fig. 2 shows superheated atmospheric steam (at very low partial pressure) at state *1*. The T-S graph then measures enthalpy of the steam above 32 F—total gray area under the constant-pressure line for state *1*. Now suppose we have saturated steam at the same temperature, state *2*; its pressure will be higher and its enthalpy is measured by the hatched area under the higher-pressure line. Compare the two areas and you'll see they are about equal, bearing out the gas-like behavior of l-p steam.

Specific humidity. We can go about measuring the humidity of air, or any gas and vapor mixture, for that matter, in several ways. Looking at one method we find:

Specific humidity = lb of water vapor per lb of dry air in a mixture, or

$$\overline{SH} = D_s/D_a = V_a/V_s \qquad (1)$$

where $\overline{SH}$ = specific humidity, lb steam per lb air

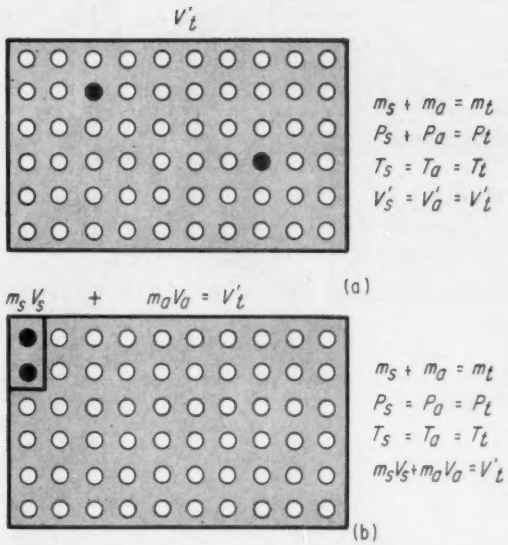
D_s = steam density, lb per cu ft

D_a = air density, lb per cu ft

V_a = air specific volume, cu ft per lb

V_s = steam specific volume, cu ft per lb

According to Dalton's Law, the



3 (a) In a mixture of air and steam, both occupy the same total volume at their individual partial pressures but at the same temperatures. (b) In volumetric analysis of an air-steam mixture both are assumed to be at same pressure and temperature

Basic laws predict behavior of mixtures

Avogadro's Law

- Equal volumes of perfect gases held under exactly the same conditions of temperature and pressure each have equal numbers of molecules. (See Part 4, POWER, Nov 1956)

Gibbs-Dalton Law

- Gases occupying a common volume each fill that volume and behave as if the others were not present. (See Part 33, POWER, Dec 1959)
- The pressure of a gas mixture is the sum of the pressures that each gas would exert if it alone occupied the volume
- Properties of a gas mixture are equal to the sums of those properties for each component when it occupies the total volume by itself; these properties are internal energy, enthalpy and entropy

Mixture equations

$$V'_{total} = V'_1 = V'_2 = V'_3 = \ldots = m_1V_1 + m_2V_2 + m_3V_3 + \ldots$$
$$T_{total} = T_1 = T_2 = T_3 = \ldots$$
$$P_{total} = P_1 + P_2 + P_3 + \ldots$$
$$R_u = M_1R_1 = M_2R_2 = M_3R_3 = \ldots = 1545$$
$$D_{total} = D_1 + D_2 + D_3 + \ldots$$
$$m_{total} = m_1 + m_2 + m_3 + \ldots$$
$$\%m_1 = (m_1/\Sigma m)100, \text{ etc}$$
$$\%m_1 + \%m_2 + \%m_3 + \ldots = 100$$
$$\%V_1 = [(m_1/M_1)/\Sigma(m/M)]\ 100, \text{ etc}$$
$$\%V_1 + \%V_2 + \%V_3 + \ldots = 100$$

By B G A SKROTZKI, Associate Editor

steam and air occupy the same volume and each exerts its own partial pressure to add up to the total, so we can consider one cu ft of mixture for convenient calculation.

From the perfect gas equation:

$V = R_u T/MP$

where $R_u/M = R$; M being the molecular weight of the gas or vapor. Substituting in equation (1):

$$\overline{SH} = \frac{\dfrac{R_u T_a}{M_a P_a}}{\dfrac{R_u T_s}{M_s P_s}} = \frac{M_s P_s}{M_a P_a}$$

since $T_a = T_s$ = temperature of mixture. Then:

$$\overline{SH} = \frac{18\,P_s}{29\,P_a} = 0.622\,\frac{P_s}{P_a} \qquad (2)$$

where we take 18 as the molecular weight of H_2O and 29 as the molecular weight of the dry-air mixture of O_2 and N_2.

Example: An air-steam mixture has 4% of its volume in steam at standard atmospheric pressure and 90 F. Find its specific humidity.

To solve this problem we must first establish a relation between ratios of volumes, ratios of pressures and mass of components. Fig. 3*a* shows the mixture of steam and air for a total volume V'_t having a mass of steam m_s and mass of dry air m_a for a total mass $m_t = m_s + m_a$.

First let's find the ratio of steam partial pressure P_s to total mixture pressure P_t. Starting with Dalton's Law:

$$P_t = P_s + P_a = \frac{R_u T_t}{M_s \dfrac{V'_t}{m_s}} + \frac{R_u T_t}{M_a \dfrac{V'_t}{m_a}} = \frac{R_u T_t}{V'_t}\left(\frac{m_s}{M_s} + \frac{m_a}{M_a}\right)$$

Then taking the ratio P_s/P_t and substituting, we get:

$$\frac{P_s}{P_t} = \frac{\dfrac{m_s}{M_s}}{\dfrac{m_s}{M_s} + \dfrac{m_a}{M_a}} \qquad (3)$$

But when we separate the steam and air for a volumetric analysis as in Fig. 3*b*, with each component at the pressure and temperature of the original mixture, we start with the basic relation:

$$m_s V_s + m_a V_a = V'_t$$
$$V'_t = m_s \frac{R_u T_t}{M_s P_t} + m_a \frac{R_u T_t}{M_a P_t} = \frac{R_u T_t}{P_t}\left(\frac{m_s}{M_s} + \frac{m_a}{M_a}\right)$$

Then the volumetric proportion of steam in the mixture is:

$$\frac{m_s V_s}{V'_t} = \frac{\dfrac{m_s}{M_s}}{\dfrac{m_s}{M_s} + \dfrac{m_a}{M_a}} = \frac{\%V_s}{100} \qquad (4)$$

(See table above for general form of this equation.) But this has the same value as equation (3) so we can immediately write:

$$\frac{\%V_s}{100} = \frac{P_s}{P_t} \qquad (5)$$

Then for our problem:

$$\frac{\%V_s}{100} = 0.04 = \frac{P_s}{P_t}$$

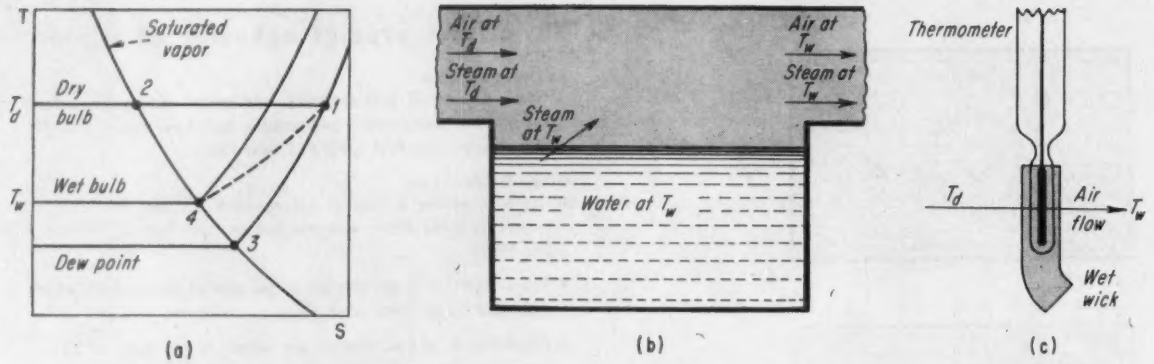
Substituting:

$$0.04 = \frac{P_s}{14.7}$$
$$P_s = 0.588 \text{ psia}$$
$$P_a = 14.7 - 0.588 = 14.112 \text{ psia}$$

Then substituting in equation (2):

$$\overline{SH} = 0.622\,\frac{0.588}{14.112} = 0.0259 \text{ lb vapor per lb dry air}$$

Relative humidity, the measure most often quoted, is defined as: *Relative humidity of a mixture is the ratio of density of water vapor in the mixture to density of saturated water vapor at the temperature of the mix-*



4 (a) Wet-bulb temperature of an unsaturated steam-air mixture falls between the dry-bulb and the dew-point temperatures. (b) Adiabatic steady-flow process of unsaturated air over the water cools mixture to wet-bulb level as in wet-bulb thermometer at (c)

ture, or in equation form:

$$\overline{RH} = \frac{D_s}{D_g} = \frac{V_g}{V_s} \qquad (6)$$

Relating this to Fig. 2, V_s would be at state *1*, a superheated vapor, while V_g would be at state *2*, a saturated vapor at the same temperature (but a higher pressure).

We can state this relation in terms of partial pressures. Substituting from the perfect gas equation in (6) we get:

$$\overline{RH} = \frac{\frac{RT_t}{P_g}}{\frac{RT_t}{P_s}} = \frac{P_s}{P_g} \qquad (7)$$

By finding the value of P_s from equations (2) and (7) and equating, we find that:

$$\frac{\overline{SH}\,P_a}{0.622} = \overline{RH}\,P_g$$

$$\overline{RH} = \frac{\overline{SH}}{0.622}\,\frac{P_a}{P_g} \qquad (8)$$

Carrying on with the previous example we can find the $\overline{RH}$ by substituting in equation (8) to get:

$$\overline{RH} = \frac{0.0259}{0.622}\,\frac{14.112}{0.6982}$$
$$= 0.8416 \text{ or } 84.16\%$$

Here 0.6982 psia is the steam saturation pressure for the 90-F mixture.

Dew point of a mixture is another method of measuring its humidity. To define:

Dew point is the temperature of a mixture at which liquid water starts forming when the mixture cools at constant pressure.

We can explain this in Fig. 2. Here the temperature of the steam in the mixture (and of the mixture) is defined by state *1*. As the mixture cools at constant total pressure, steam state falls from *1* to *3* where the steam begins to condense with further cooling.

Note that this definition specifies a constant-total-pressure cooling process. Since the steam cools at its constant partial pressure from initial temperature T_1, dry air must also cool at its constant partial pressure. Evaluating this:

$$P_s = \frac{R_s T}{V_s}$$

$$P_t = \frac{R_t T}{V_t}$$

$$\frac{P_s}{P_t} = \frac{R_s V_t}{R_t V_s}$$

Since the air and steam occupy the same total volume it follows that:

$$V'_t = m_s V_s = m_a V_a$$
$$= (m_s + m_a) V_t$$

Then

$$\frac{P_s}{P_t} = \frac{R_s m_s}{R_t (m_s + m_a)}$$

Thus partial pressures and the total pressure remain unchanged during the cooling process providing the mass of steam and the mass of air stay constant (total volume does change, however). Partial pressure of the steam in a mixture is the saturation pressure corresponding to the dew point.

Again referring to the previous example, $P_s = 0.588$ psia. Looking in the Steam Tables we find a corresponding saturated temperature of 84.58 F; this is the dew point of the mixture.

If a mixture is cooled below the dew point, state *3* in Fig. 2, some vapor condenses to liquid and pressure of the remaining vapor will be the saturation pressure corresponding to mixture's temperature.

Wet-bulb measurement. The easiest method of measuring humidities uses the wet-bulb thermometer. This is a thermometer with its bulb covered by a soaking wet wick, Fig. 4*c*. An air-steam mixture to be measured is made to flow rapidly over the wick. If the mixture is unsaturated (below 100% relative humidity), water evaporates from the wick to join the mixture and raise it to saturation.

No heat is supplied to the process for water evaporation, making this an adiabatic process. Usually the water can only evaporate by loss of its faster molecules, so it cools down to a lower temperature. The level to which it cools depends on the degree of saturation of the steam-air mixture. When the entering mixture is fully saturated, as many molecules from the steam enter the water in the wick as leave the wick to join the steam. Water in the wick and the air-steam mixture passing it do not change temperature, so the wet-bulb thermometer will read the same as a wickless dry-bulb thermometer.

But as humidity of the entering air-steam mixture drops, the wet-bulb reading falls below the corresponding dry-bulb reading. Fig. 4*a* shows the relation of the various steam temperatures on section of a T-S chart. Point *1* shows state of the superheated steam in the mixture approaching the wet-bulb thermometer at its dry-bulb

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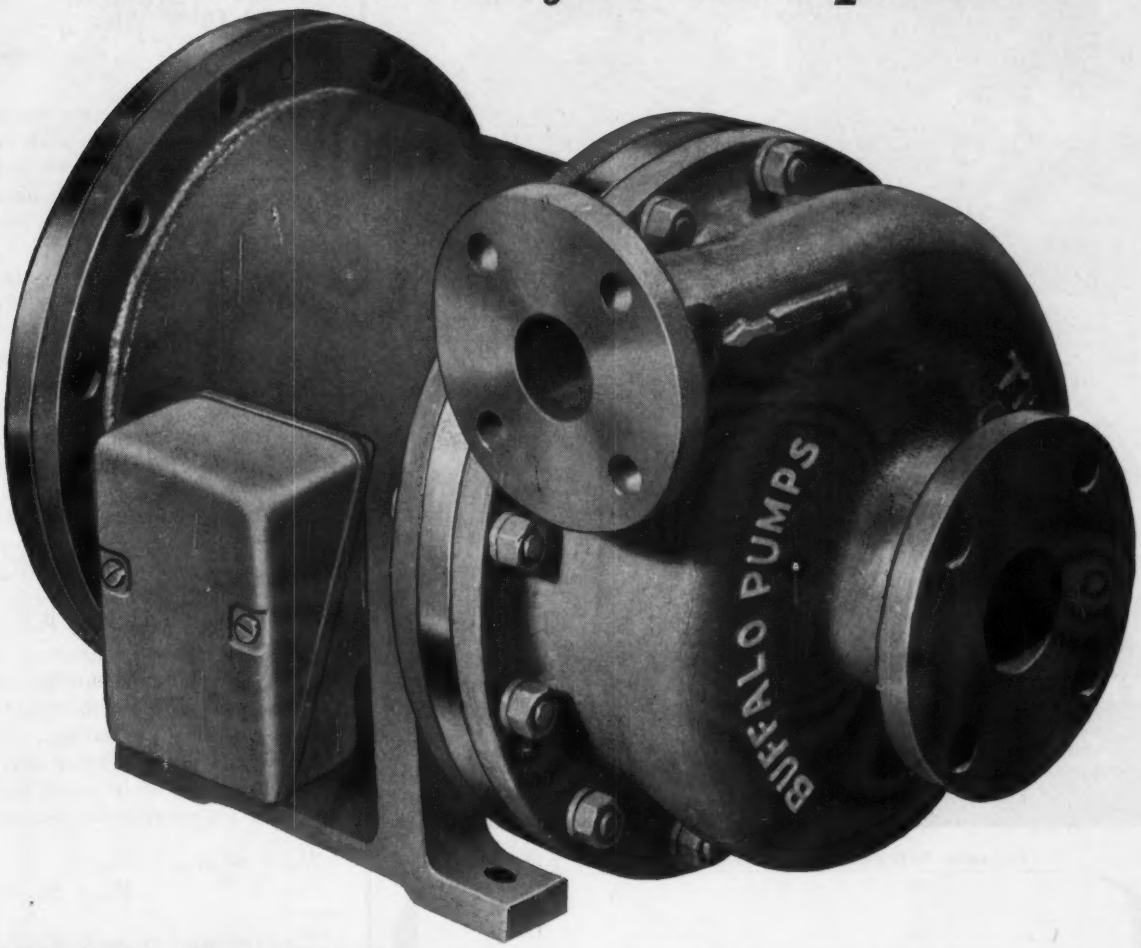

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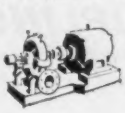

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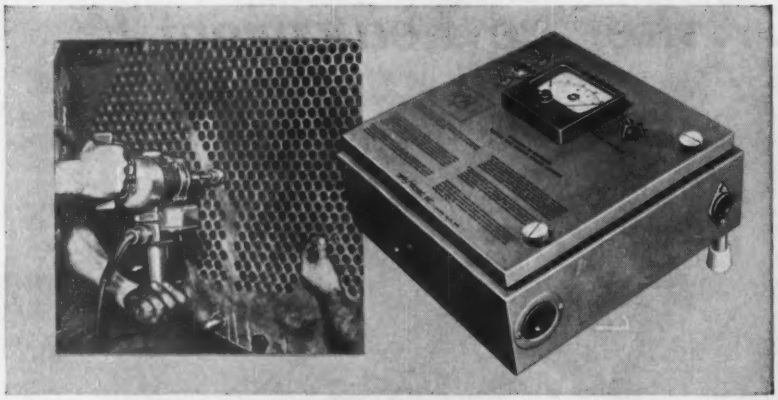

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Thermo refresher

Begins on page 144

temperature. State *2* shows the corresponding saturation pressure, and state *3* the corresponding dew point. State *4* shows the wet-bulb temperature which lies between the dry-bulb and dew-point levels.

Process *1-4* indicates the change of state for the steam in the mixture. Note that it gives up heat as indicated by the area under the process line even though the overall mixture process is adiabatic. This goes toward evaporating water from the wick. In other words, heat is exchanged between components of the system.

Fig. 4*b* shows a water-removal or drying process that parallels the wet-bulb thermometer. Unsaturated air-steam mixture flows over water to be removed from a chamber. For stabilized steady-flow conditions the water will be at the wet-bulb temperature T_w, same as the temperature of the air-steam mixture leaving.

Let's write the steady-flow energy equation for Fig. 4*b* in terms of one lb of dry air entering the chamber:

$$H_{ad} + \overline{SH}_d H_{sd} + ZH_{fw} = H_{aw} + \overline{SH}_w H_{sw}$$

where

H_{ad} = enthalpy of one lb of dry air entering at dry-bulb temperature t_d, Btu per lb

$\overline{SH}_d$ = specific humidity of entering air-steam mixture at t_d, lb steam per lb air

H_{sd} = enthalpy of one lb steam in mixture entering, Btu per lb

Z = lb of water evaporated into mixture at t_w per lb of dry air entering

H_{fw} = enthalpy of water evaporated into mixture at t_w, Btu per lb

H_{aw} = enthalpy of one lb of dry air leaving at wet-bulb temperature t_w, Btu per lb

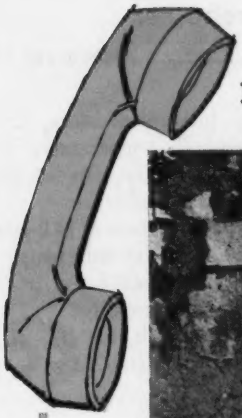
$\overline{SH}_w$ = specific humidity of saturated air-steam mixture leaving

H_{sw} = enthalpy of one lb steam in mixture leaving at t_w, Btu per lb

From the process we see that the specific humidity of the air-steam mixture increases with addition of the water; then $Z = \overline{SH}_w - \overline{SH}_d$. Making the substitution and solving:

$$\overline{SH}_d = \frac{\overline{SH}_w(H_{sw} - H_{fw}) + H_{aw} - H_{ad}}{H_{sd} - H_{fw}} \quad (9)$$

continued



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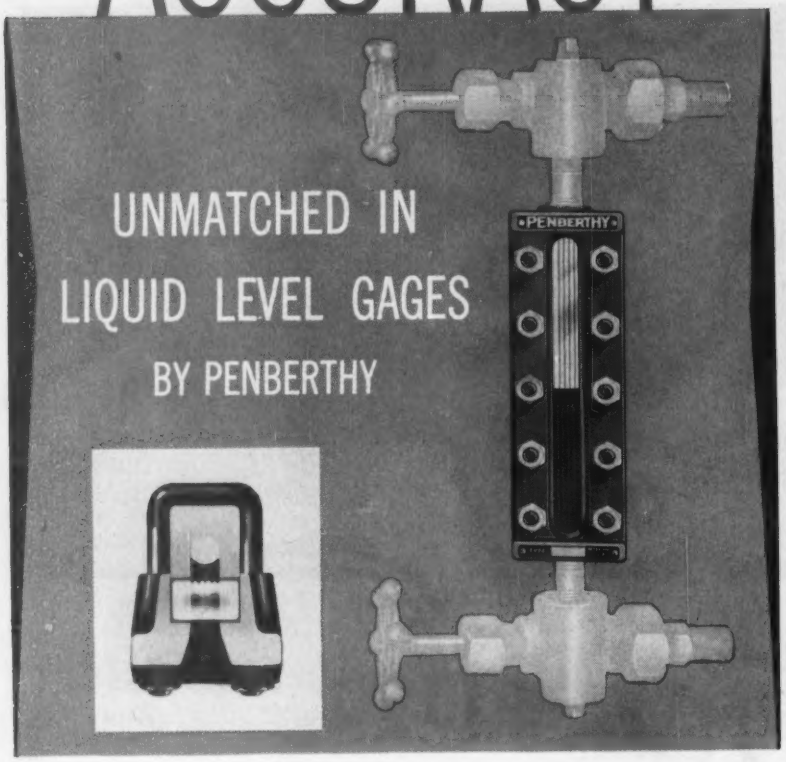

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Thermo refresher

Begins on page 144

Knowing the mixture pressure, dry-bulb and wet-bulb temperatures we can figure specific humidity of the incoming air-steam mixture.

Example: Atmosphere at 14.0-psia total pressure has a dry-bulb temperature of 70 F and a 60-F wet bulb. What is its specific humidity?

First let's remember that $H_{aw}-H_{ad} = c_p\,(t_w-t_d) = 0.24\ (60\text{-}70) = -2.4$ Btu per lb.

From equation (2):

$$\overline{SH}_w = 0.622\,\frac{P_{sw}}{P_{aw}}$$

P_{sw} is the saturation pressure corresponding to $t_w = 60$ F. (The steam tables list this as 0.2563 psia. $P_{aw} = 14.0 - 0.2563 = 13.7437$ psia; then:

$$\overline{SH}_w = 0.622\,\frac{0.2563}{13.7437}$$

$= 0.0116$ lb steam per lb dry air

H_{sw} will be the same as the saturation H_g at 60 F, or 1088.0 Btu per lb. H_{fw} is the saturation H_f at 60 F, or 28.06 Btu per lb. H_{sd} is the same as the saturation H_g at 70 F, or 1092.3 Btu per lb. Substituting in equation (9):

$$\overline{SH}_d = \frac{0.0116(1088.0-28.1)+2.4}{1092.3-28.1}$$

$= 0.00931$ lb steam per lb air

We can convert this to relative humidity by:

$$\overline{RH}_d = \frac{\overline{SH}_d\ P_{ad}}{0.622\,P_{gd}}$$

First let's find P_{ad} by equation (2):

$$P_{ad} = 0.622\,\frac{P_{sd}}{\overline{SH}_d} = 0.622\,\frac{P_t - P_{ad}}{\overline{SH}_d}$$

$$P_{ad} = \frac{\dfrac{0.622}{\overline{SH}_d}P_t}{1+\dfrac{0.622}{\overline{SH}_d}}$$

$$P_{ad} = \frac{\dfrac{0.622}{0.00931}\times 14.0}{1+\dfrac{0.622}{0.00931}} = 13.78 \text{ psia}$$

Substituting in the above conversion equation:

$$\overline{RH}_d = \frac{0.00931}{0.622}\,\frac{13.78}{0.3631}$$

$= 0.568$ or 56.8%

Dew point of the air-steam mixture entering is the saturation temperature of $P_{sd} = 14.0 - 13.78 = 0.22$ psia, or 55.8 F.

Next part looks at processes of air-steam mixtures and their calculation.

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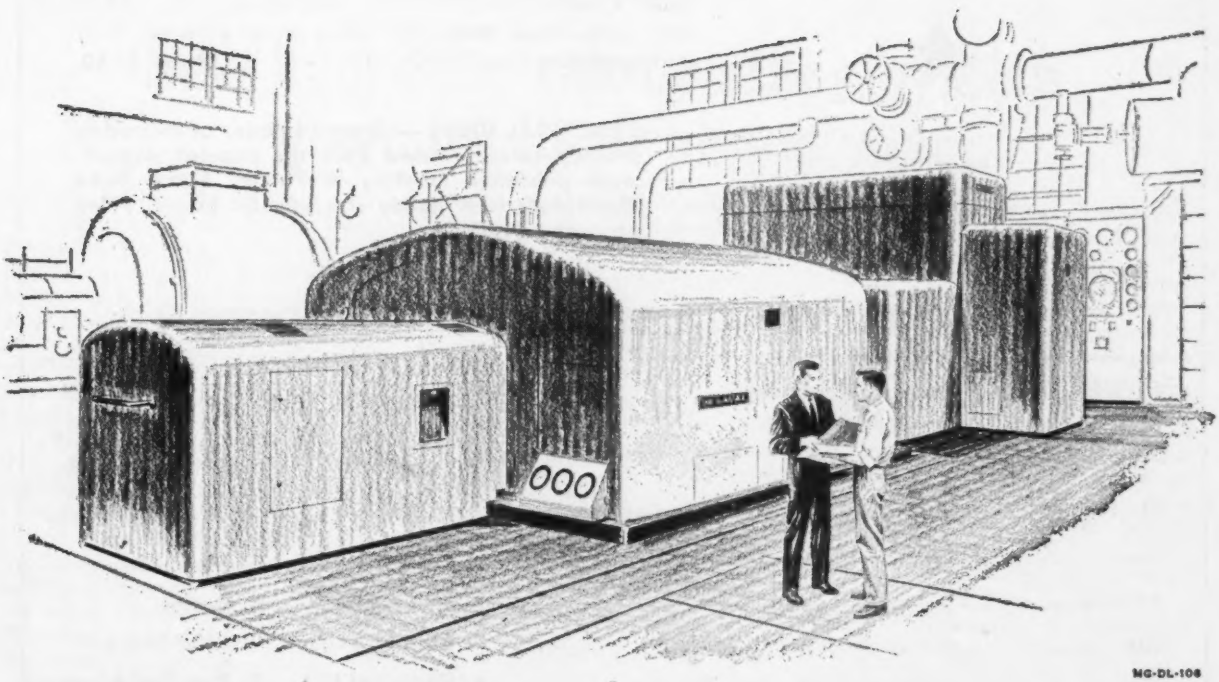

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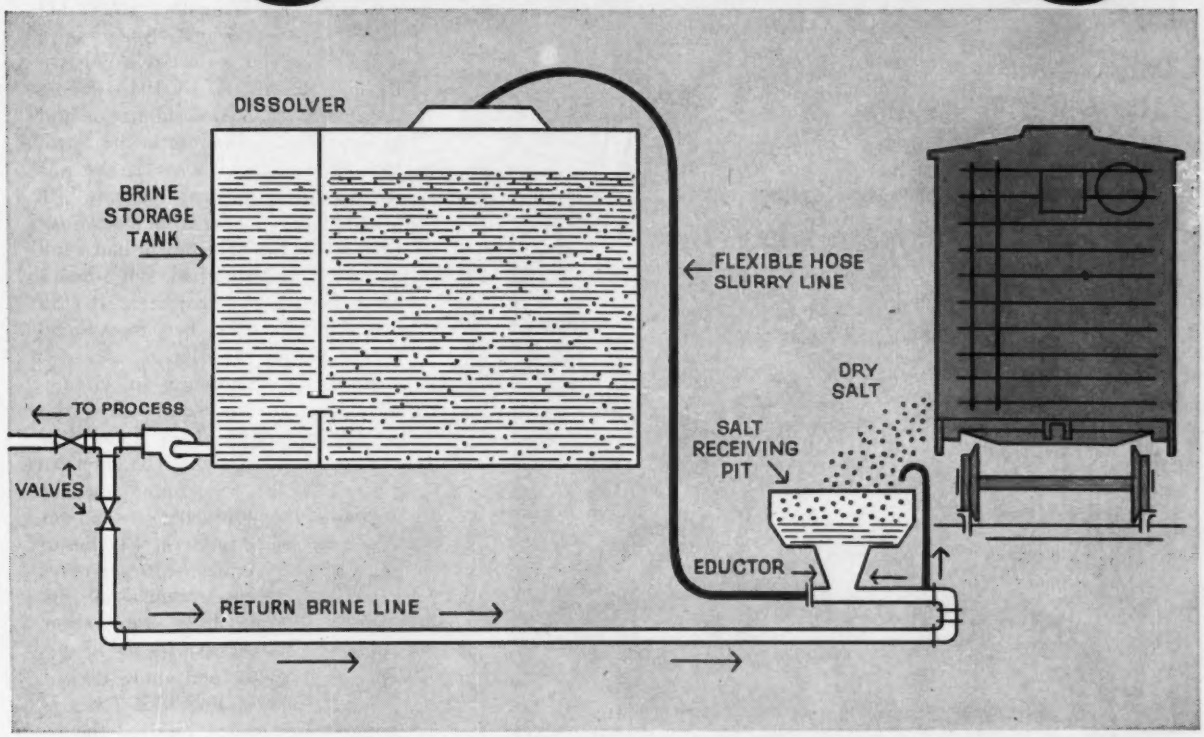
salt engineering



New hydraulic salt-handling system pays for itself in one year

A food-specialties manufacturer used to buy evaporated salt in bags. They used a batch mixing process to combine the salt with other ingredients to produce a patented product. Lugging the salt from boxcar to the plant, storing it, then dumping into mixing vats was time-consuming, expensive and took up valuable warehouse space.

In an effort to speed up and economize on the operation, this manufacturer called in an International Salt Company Technical Service Representative. He recommended simplifying the mixing process by installing a Storage Brinomat* Dissolver outside the plant. The Dissolver automatically supplies sparkling, pure brine to the process *continuously*.

He also recommended buying less expensive bulk salt by the carload and delivering it to the Dissolver by a hydraulic handling system. In this system, designed by International's Technical Service Department (see diagram above), a power scoop pushes salt from the cars into a receiving hopper feeding an eductor system. There the salt is mixed with brine from the Dissolver and educted as a slurry of saturated brine and undissolved salt to the Dissolver.

Efficiency and economy have been remarkable. After one year of operation the plant manager informed International that the entire system had already paid for itself!

Hydraulic handling systems can be designed to unload, move and store any amount and type of salt—rock or evaporated.

With over fifty years' experience, International is uniquely equipped to offer assistance on all phases of salt or brine usage. Even if you're satisfied with your present operation, perhaps it *could* be improved. Why not review your operation with an International Technical Service Representative? Salt is his business. Write International Salt Company, Clarks Summit, Pa., or call our nearest district office.

*Registered T.M. International Salt Company

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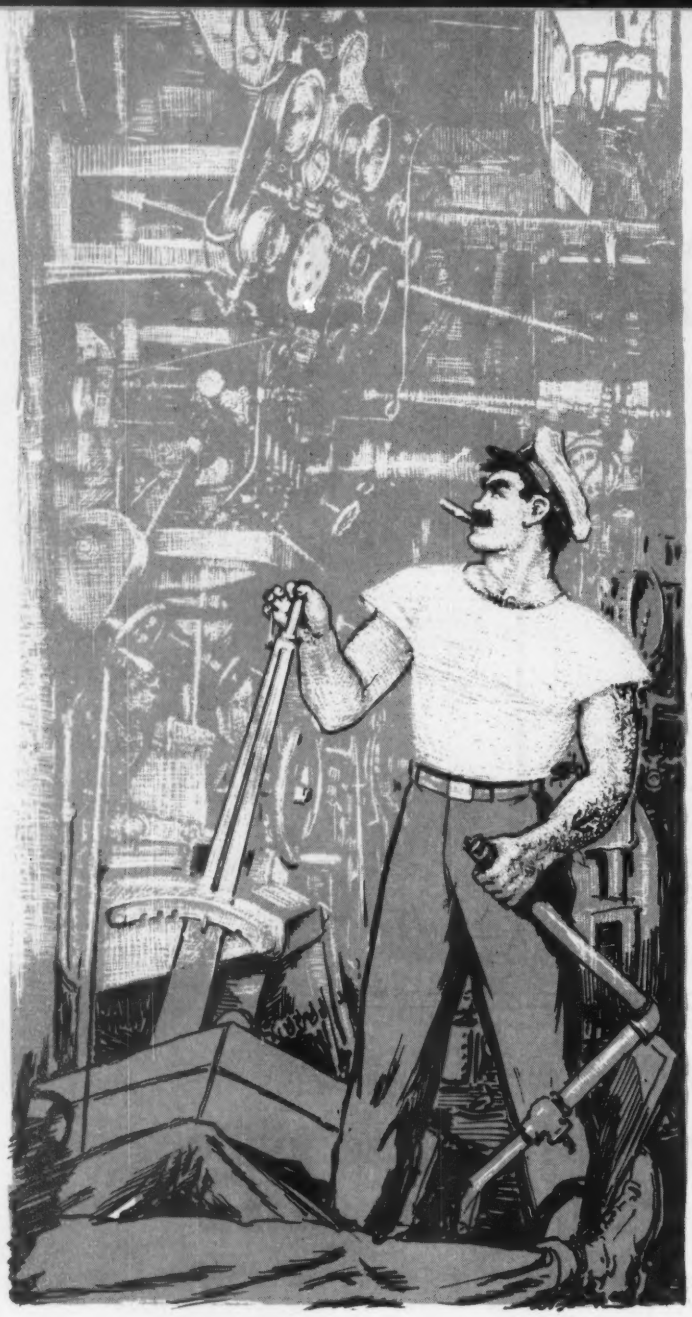


Violence was indicated all around. To deepen the mystery, Marmaduke found the diesel's starting-air bottles empty and the day tank was contaminated

Marmy's inboard-outboard

Not since the epic sea mystery of the abandoned *Marie Celeste* rocked the maritime world to its barnacled bottoms had there been anything like it. Of course, the *Marie Celeste* was a wooden brig, while the *M V Pyrgos* was a large, modern steel-hulled motor vessel with plenty of power.

The brig *Marie Celeste* was sighted near the Spanish coast by a sailing ship at 10 am on the seventh of December, 1872. She was under full sail. When the passing ship got no answer, a boarding party rowed over to investigate. No one was found aboard—and there were no signs of violence. A meal was laid on the table in the after-cabin. The brig's two boats had not been removed from their chucks—so what happened to the crew? This version of the story is argued in fo'c's'les to this very day.

The *Pyrgos* is another story, but almost as mysterious. She was a diesel tanker flying the Greek flag. On the morning of July 18, 1943, during the height of the Nazi submarine and air assaults on shipping in the North Sea during World War II, she was sighted drifting near latitude 10, longitude 62, not far from the Danish Paeroes Islands. The tanker had a full cargo of Bunker-C fuel. But when a party from the destroyer escort *USS Sea Witch* boarded her, they found no one aboard . . . alive.

Here the difference in circumstances aboard the *Marie Celeste* and the *Pyrgos* ends. They found the *Pyrgos*' crew, all right. The chief engineer's body was found on the engine-room floor plates — and his head was bashed in. Several bodies of officers and unlicensed personnel were found in their bunks—all apparently murdered in their sleep. There was plenty of evidence of violence, both below and above decks.

When Captain Bulkhead Jones of the *USS Sea Witch* received the report from his boarding party, he summoned his free-swinging, hard-drinking but highly competent engineering officer, Marmaduke Surfaceblow.

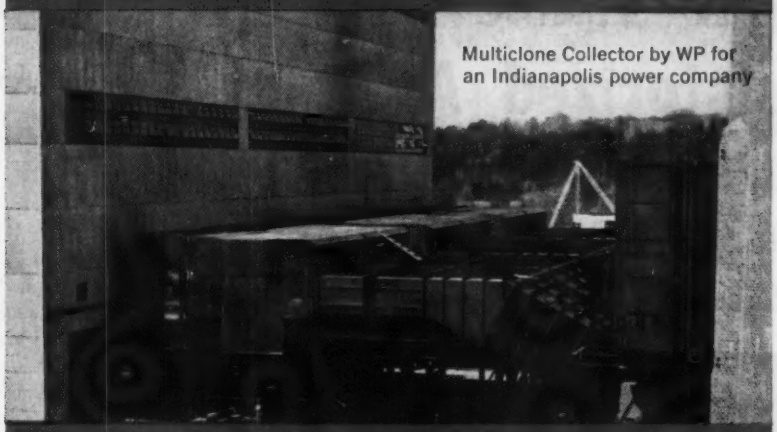
"Go aboard with a few of your best ratings, Marmy, and see if you can crank her up. Maybe we can sail her into the Orkney Islands—they're only a day's run from here. The Limeys are crying for fuel and for all the bottoms they can get. No use letting the Krauts get their bloody claws on her. I'm betting this was done by saboteurs, and they're planning to come back and tow or sail her into some German-held port."

An hour later the tough 6-ft 4-in. Marmaduke was aboard with seven of his hand-picked engine-room personnel. The navigation officer from the *Sea Witch* was given command. He also had a handful of men. A quick inspection below decks gave Marmaduke the following information:

The *Pyrgos*' main engine was a 2500-hp solid-injection diesel job.

continued

For more facts circle 299 on Reader Service card, p 109 ➤



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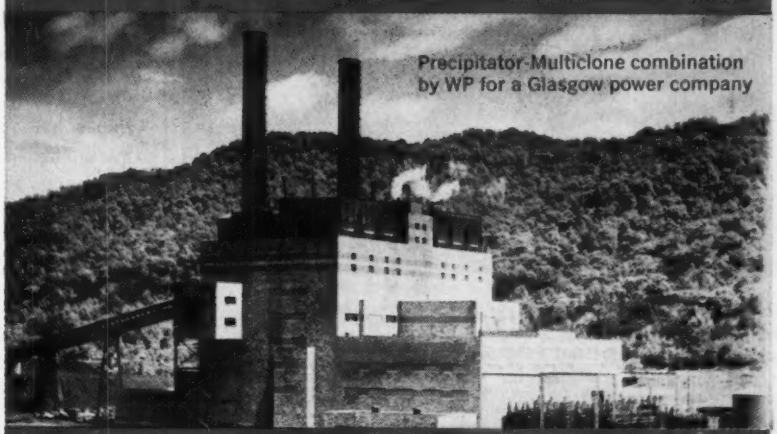

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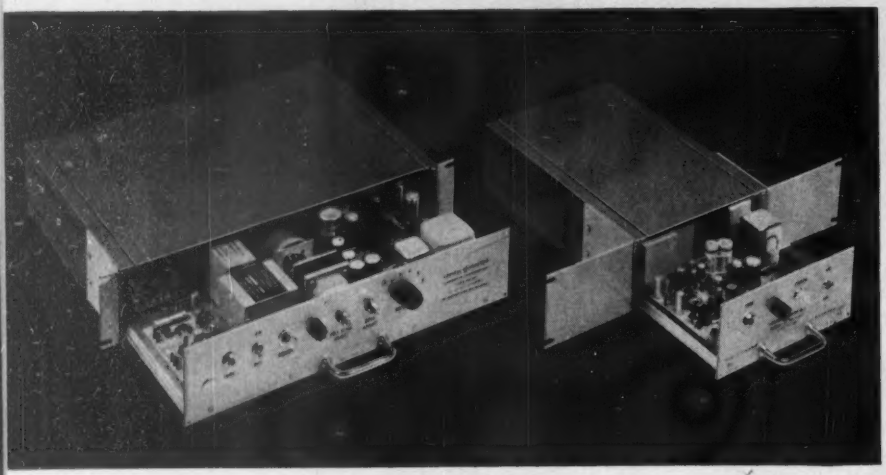

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INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

Marmaduke

She had one 200-hp auxiliary diesel directly connected to an electric generator. A second smaller diesel used for starting air was belted to an air compressor—the compressor could also be driven by an electric motor.

The main diesel seemed to be in good shape, but the fuel injectors had been carefully removed from the two auxiliary diesels — and no spares could be found aboard. To deepen the mystery, and make starting a bigger problem, Marmy found the starting-air bottles empty.

The ship had two Scotch marine firetube boilers. These were used for supplying steam to her large steam cargopumps and for heating the heavy fuel oil in cold weather. Steam was also used for heating the ship's living quarters.

The anchor engine on the bow, warping winch on the poop deck and two after-deck winches used for handling the heavy flexible fuel lines and auxiliary machinery were steam-driven, as they were aboard most diesel ships in those days.

After a quick inspection, Marmy reported to the navigation officer in charge. He also asked him to request welding equipment from Captain Bulkhead Jones.

"Ahoy Marmy, what's the problem?" blared the captain by megaphone as the D-E came cautiously near the tanker.

"No problem," roared Marmaduke in his foghorn voice from the flying bridge. "Her main engine's OK. The day fuel-oil tank's nearly full. But there's no starting air and no way to compress any. I'm lighting off a boiler with dunnage. Soon as we get steam up we'll use it to crank the main engine. That'll take us to the Orkney Islands . . . if we don't have to reverse the engine."

"Good luck," came Captain Jones' voice. "Welding equipment on the way. We'll stand by."

"Wonder what the Chief's going to do with that welding gear?" asked the assistant engineering officer aboard the *Pyrgos* a few minutes later. Without waiting for an answer, he added, "No compressed air and no way to make any . . . how's he

For more facts circle 300 on Reader Service card, p 109

Begins on page 154

going to crank that main engine?"

"I don't know," shot back the hard-boiled captain, "but I'll take odds that he'll do it. That is if the Stukas don't blow us the hell out of the water, or if a Kraut sub doesn't arrive first with engineers and those missing injectors to take her away."

Marmy put a machinist's mate to work burning a 12-in.-dia hole out of the iceflat deck directly above the main engine's flywheel. Then he cut another hole in the overhead directly above the first one.

Three hours later, there was about 50 psi of steam on the starboard boiler. She was being fired with food crates, furniture and mattresses from the crew's quarters, odd pieces of wood and trash found below decks in the storerooms.

With steam aboard, the tanker started coming to life. First the reciprocating fuel-oil pump and then the feed pumps were warmed up. Then as fuel oil slowly brought the pressure up to 200 psi, the steam-driven firepump warmed up. That would supply cooling water to the main engine . . . *if* the engine could be started.

With large portable-battery flashlights from the destroyer hung around the engine room, Marmy had his boys lug several hundred feet of fire hose below and place it near the flywheel. The sailors rigged a gin pole above the hole burned in the decks and ran a wire cable from the cargo boom through the gin-pole block, then down into the engine room.

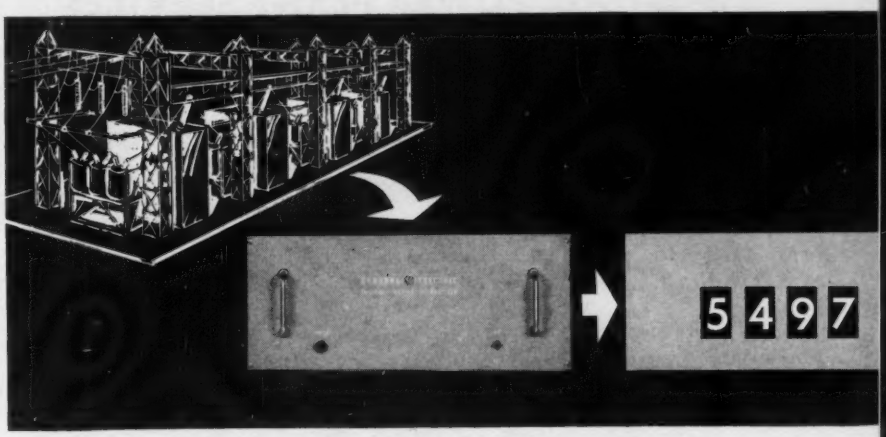
Marmy had his boys string the cable through some fire hose. Then the cable's loose end was lashed lightly to the flywheel with heaving line, so the line would break easily. The fire hose with the cable inside was wrapped tightly around the flywheel. By that time all hands got busy to make the main engine ready for starting.

The day fuel-oil tank had enough fuel for about 16 hours' sailing, Marmy figured. The oil would gravitate down to the fuel-injection pump that was directly connected to the diesel. The small fuel-oil-transfer pump was electric-driven, but once the engine started, they could get oil up to

NEW GENERAL ELECTRIC

Digital Telemetering

SYSTEM FOR FAST, HIGH ACCURACY DATA TRANSMISSION



For fastest, most accurate utility load or billing information, General Electric's all-new Digital Telemetering System brings kilowatt-hour information into load dispatching office over one channel, with *100 PERCENT ACCURACY*. Offers outstanding system values . . .

Flexibility: Digital telemetering signal can be time-multiplexed with an analog telemetering signal at a preset time interval, thus providing minimum channel expense and lower operating costs. Or the digital telemetering system can be used over its own isolated channel to transmit information on command. This system will also operate over any intermediate channel equipment capable of accommodating standard analog "frequency" telemetering signals.

Accuracy: Digital receiver self-checking feature permits only the read-out of correct numbers.The receiver will cancel the readout if there has been an incorrect code or interference of the coded signal during transmission.

Speed: Digital transmission is in the form of long and short pulses at average rate of 10 cps. A six digit number can be telemetered in less than five seconds.

Design: System utilizes time-proved relays and stepping switches that require minimum maintenance. No tubes or transistors are used. Equipment is furnished in 19-inch rack, dust-proof cases with slide-out drawers.

Cost: System price is usually less than the cost of comparable integrating devices which it now obsoletes.

Various read-out devices are available depending on your requirements. These include: electric typewriter, visual digital display units and tape punch equipment if you wish to use the information in a digital computer. Digital transmitters and receivers can be provided for either 4, 6 or 8 digit numbers.

For additional information on the all-new G-E Digital Telemetering System, just call your nearest General Electric sales office, ask for a copy of bulletin GEZ-3312, or write direct to General Electric Company, Section 599-07A, Schenectady 5, N. Y. In Canada, contact Canadian General Electric Company Ltd., 940 Lansdowne Avenue, Toronto 4, Ontario.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

For more facts circle 301 on Reader Service card, p 109

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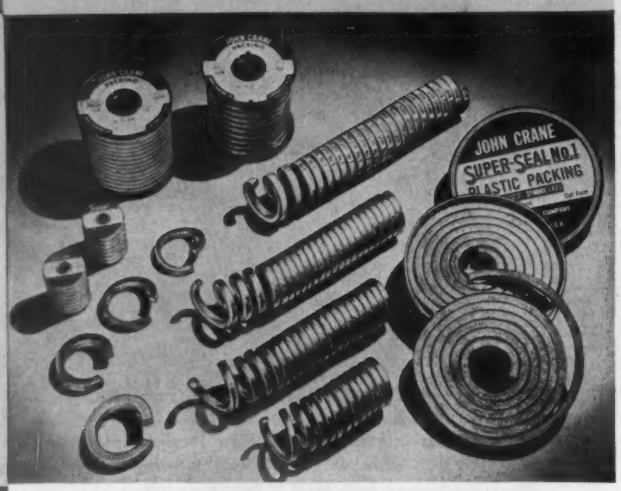
TO GET THE RIGHT PACKING for ALL POWER PLANT SERVICES



Check your problem. It may be in the handling of boiler feed water . . . saturated or superheated steam . . . condensate . . . drain water . . . refrigerants.

Check "John Crane's" complete line of packings for the power plant. You'll find that "John Crane" engineers have designed and developed a particular type of packing to meet your individual applications or service condition.

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Check "John Crane" for quality and availability. Only the finest materials, binders and lubricants are used, forming a resilient, flexible, non-frictional strong packing. Completely stocked warehouses throughout United States and Canada give you prompt service in the quantity you need.

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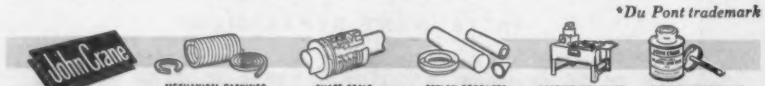


CRANE PACKING COMPANY

Marmaduke

Begins on page 154

the day tank by bucket brigade if needed. Besides, the *Pyrgos* was within 200 miles of the Orkney Islands . . . an easy day's sailing.

To make cranking easier, the air cocks on each of the eight 18-in.-dia cylinders were opened and four men were stationed near them for quick closing. Hot boiler feedwater had been circulated through the engine's jacket to heat it. The engine's lube oil had also been heated with a jury-rig steam coil and then the warm oil circulated through the engine with a small, gear type hand pump. These were all cold-weather starting precautions—and it wasn't cold. But Marmy wasn't sure he could even crank that big engine fast enough to get the needed firing temperature. Every degree of temperature was priceless.

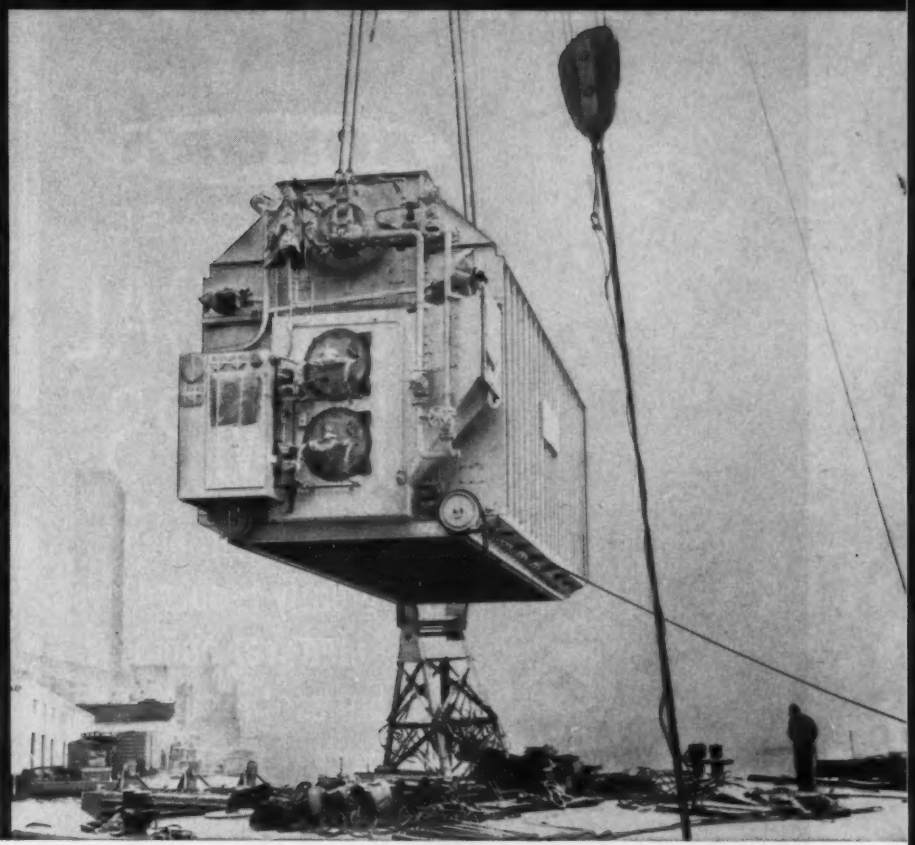
When all was ready, Marmaduke stood by the controls of the main engine. His chief machinist's mate was standing by the steam winch on deck, constantly working her back and forth within the slack cable to keep her thoroughly warm and thus avoid slugs of water. The mate had instructions to open the throttle wide soon as the cable was taut, so the winch would turn the diesel engine at its fastest speed. Then he was to slam the throttle shut soon as he felt the cable whip off the flywheel after breaking the heaving line.

Finally, Marmy's foghorn voice exploded through the engine-room skylight, "GIVE 'ER THE GUN!"

The chief machinist's mate yanked up on the throttle. The gin pole and rigging shuddered and groaned as the cable tightened—then the big diesel started turning, slowly at first, then faster and faster.

Marmy opened the fuel throttle. Just as the cable yanked loose from its lashed end, several cylinders fired, shooting flames out of their air cocks. Then the flywheel suddenly stopped spinning.

"OK, boys . . . can do!" roared Marmaduke. "Let's rig her up again." This time, soon as the flywheel started turning, the air cocks were shut to compress the maximum amount of air and thus obtain the highest firing



VIA RAIL, BARGE AND TRUCK:

two 100,000 lb/hr steam generators move into heart of New York City

En route to Pennsylvania Station South Housing Project in Manhattan, this pair of Union Type MH Packaged Steam Generators demonstrates how steam requirements (in excess of 100,000 lbs./hr.) can be fulfilled without involving field assembly.

Placed by the contractor, Raisler Corporation, the two units were shipped complete with refractories, casing, forced draft fans, motor drives, MH Firing Units, and connecting duct work. Equipped for burning No. 6 oil, each of the MH's has a capacity of 100,000 lbs./hr. at 450 psi and 600° F.

Shop assembled to standardized designs, Type MH Steam Generators and Firing Units can be supplied to handle diversified needs without costly special engineering. They can be arranged for oil or gas firing or both, with fully automatic, semi-automatic or manual control. The symmetrical, 3-drum MH design, with the top drum centered, makes it possible to ship larger units within existing rail clearances.

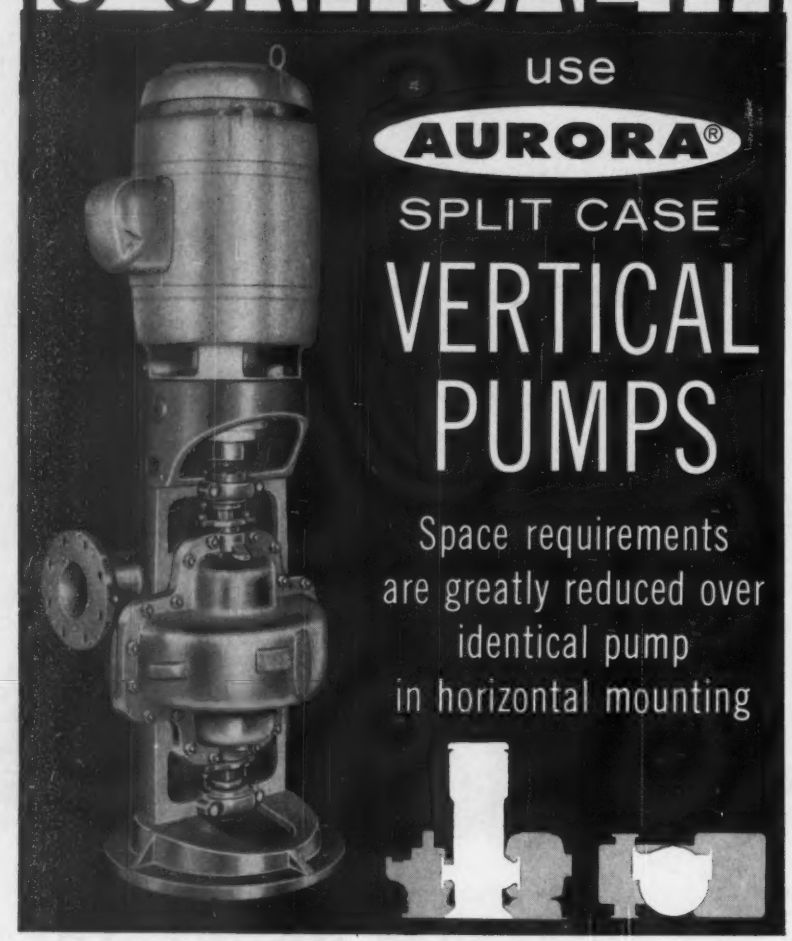
For detailed information, contact your local Riley Stoker Corporation or Union Iron Works office.

UNION

UNION IRON WORKS
ERIE, PENNSYLVANIA
A DIVISION OF RILEY STOKER CORP.

For more facts circle 303 on Reader Service card, p 109

WHERE SPACE IS CRITICAL...



In addition to the substantial reduction in floor space with the vertical base mounting, these pumps have opposed suction and discharge connections which permits rotation of the unit to accommodate simplified piping, saving wall space and reducing installation costs.

All of the easy-accessibility features of the horizontal split case pumps are retained. Simply remove the cover for inspection, adjustment, or removal of the rotating element without disturbing the piping or motor.

Available in single-stage double suction or two-stage opposed suction types. Capacities range up to 6000 GPM and heads to 600 feet with continuous operation.

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Begins on page 154

temperature. First one and then another cylinder fired as Marmy opened up on the fuel throttle.

Fourteen hours later, under a curtain of heaven-sent fog, during which time the destroyer escort had sailed rings around the *Pyrgos* in a constant alert to detect enemy planes and submarines, the tanker finally dropped anchor in a sheltered cove in the Orkney Islands.

Soon as the salvage party got back aboard the *Sea Witch*, she shoved off again—a merchant fleet returning from the Murmansk run was being attacked by a wolf pack of subs.

Six hours later, Marmy was stowing away a half-dozen sunny-side-ups and washing them down with a pot of black coffee in the wardroom of the *Sea Witch*. He had been on his feet, part of the time while at general quarters and under constant attack, for 35 hours.

"Why didn't you start that diesel engine with a bottle of CO_2?" asked the assistant engineering officer, sliding to his place on the long seat. "I always heard that's the thing to do." The assistant was a good man, in spite of being a 90-day wonder.

Marmy took a long drag on his cigar, then rubbed his bloodshot eyes and stubble chin with a huge calloused fist. "I tried that gimmick years ago and cracked a cylinder liner," came his deliberate answer in a gravelly voice. "Maybe I could of hooked a CO_2 bottle to the starting-air line with a long piece of pipe, then heated the pipe with a blowtorch or a jet of steam to keep the expanding gas's temperature down. But I didn't want to cool those cylinders," he explained. Then, looking his assistant square in the eye, he warned, "Before you go trying a stunt like that, make damn sure you have CO_2 and not a bottle of oxygen. I knew a guy who blew a stationary diesel engine into the next state that way—and he was taken along for the ride."

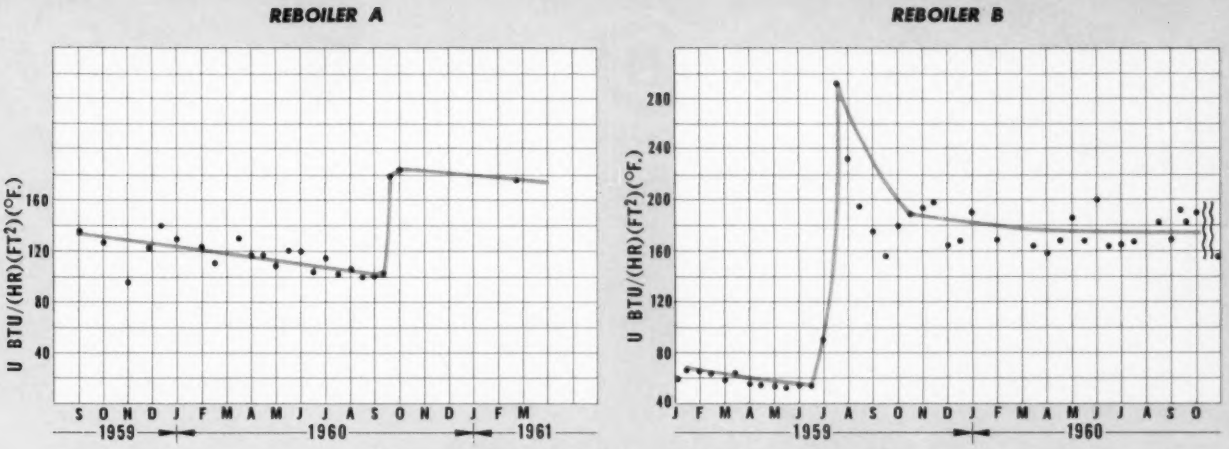
By then the officers in the wardroom crowded around Marmy, bursting with questions.

"What you make of that abandoned ship?" asked the gunnery officer. "Why didn't the saboteurs keep

continued on p 164

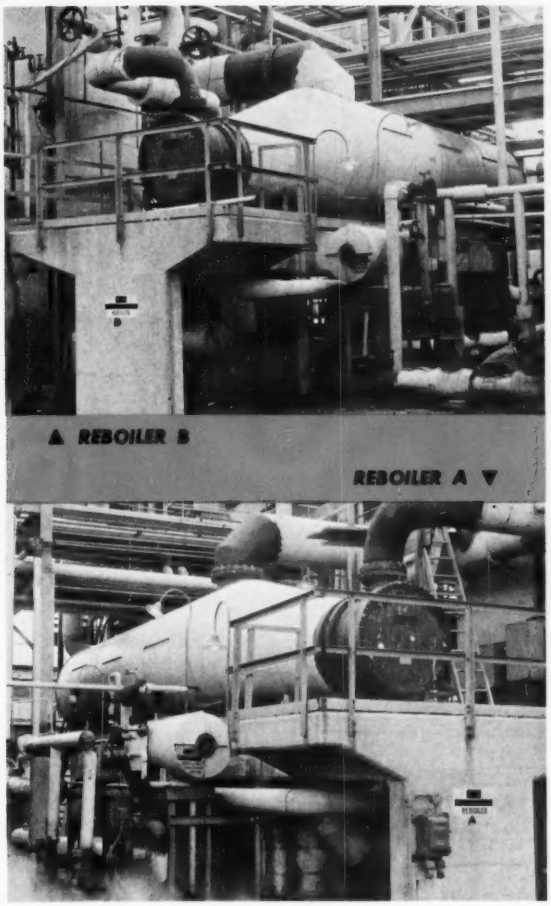
For more facts circle 304 on Reader Service card, p 109

circle 305 on Reader Service card, p 109 ➤



FRACTIONATING TOWER REBOILER COEFFICIENTS

Wolverine Trufin® Type S/T helps Sun Oil boost reboiler capacity



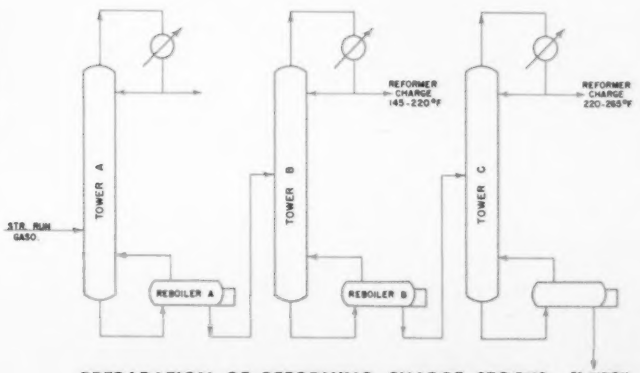
How Wolverine Trufin Type S/T–the integrally finned heat exchanger tube–boosts both tube surface area and heat transfer capacity is graphically shown by a recent Trufin installation at Sun Oil's Marcus Hook refinery.

In this application–preparing reformer feed stocks–two reboilers, tubed with bare tubes on triangular pitch, were retubed on a square pitch with Trufin Type S/T low carbon steel tubes in U-bend form.

Surface area in each unit jumped from 4400 to more than 9000 square feet. Following its retubing with 486 Trufin U-bends in June, 1959, the calculated overall coefficient of heat transfer in Reboiler B rose from a level of 60 on the bare tubes to 290 on the Trufin tubes and then, with normal fouling, leveled off at approximately 180–a threefold increase.

In the case of Reboiler A, which was retubed in September, 1960, with similar Trufin Type S/T U-bends, the calculated heat transfer coefficient rose from approximately 100 on the bare tubes to 180 on the Trufin tubes where it also leveled off.

Operations such as this, where excessive fouling on the outside of the tubes is normally encountered can, in many cases, be given a substantial performance boost through the use of Wolverine Trufin Type S/T. Why not get the Trufin story before retubing? Just ask your Wolverine salesman–HE KNOWS. Write, too, for a copy of the Trufin Catalog.



PREPARATION OF REFORMING CHARGE STOCKS

WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
DEPT. Q, 17268 SOUTHFIELD RD., ALLEN PARK, MICH.
TUBEMANSHIP in Copper—Copper Alloys—Aluminum—Special Metals

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES

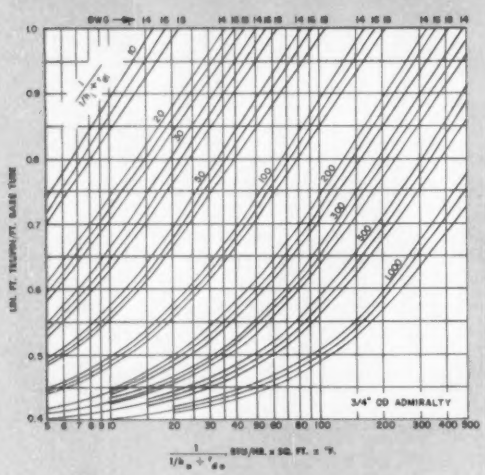


FIG. 4

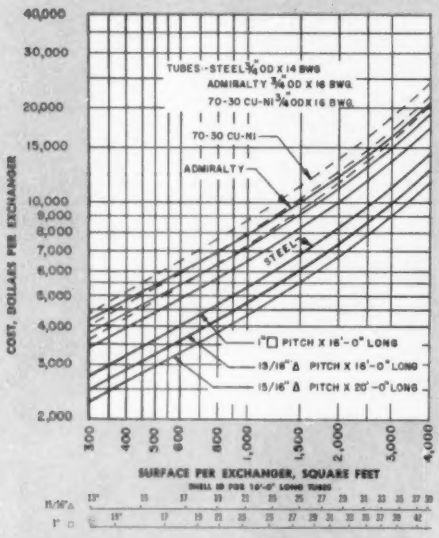

TUBES - STEEL 3/4" OD X 14 BWG
ADMIRALTY 3/4" OD X 16 BWG
70-30 CU-NI 3/4" OD X 16 BWG
70-30 CU-NI
ADMIRALTY
STEEL
1" □ PITCH X 16'-0" LONG
15/16" Δ PITCH X 16'-0" LONG
15/16" Δ PITCH X 20'-0" LONG
COST, DOLLARS PER EXCHANGER
SURFACE PER EXCHANGER, SQUARE FEET

FIG. 8

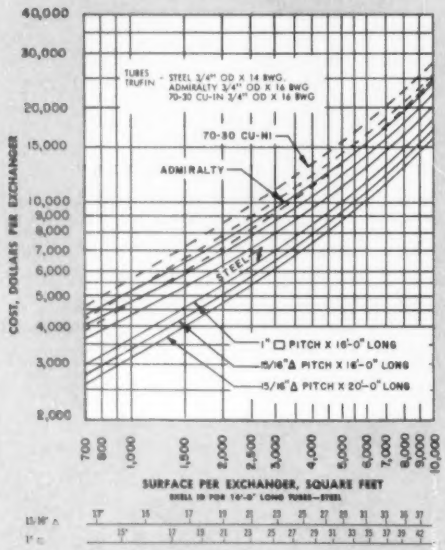

TUBES - STEEL 3/4" OD X 14 BWG.
ADMIRALTY 3/4" OD X 16 BWG.
70-30 CU-NI 3/4" OD X 16 BWG.
70-30 CU-NI
ADMIRALTY
STEEL
1" □ PITCH X 16'-0" LONG
15/16" Δ PITCH X 16'-0" LONG
15/16" Δ PITCH X 20'-0" LONG
COST, DOLLARS PER EXCHANGER
SURFACE PER EXCHANGER, SQUARE FEET

FIG. 10

Rate it for yourself!

Here's a "DO-IT-YOURSELF" test designed exclusively for technical people engaged in heat transfer operations. By using the technical data on this page, you can quickly make a comparison test that will show you the actual savings you can achieve by retubing bare-tubed heat transfer units with Wolverine Trufin® Type S/T—the integrally finned heat exchanger tube.

We're sure you'll be amazed when you see—for yourself— the savings Wolverine Trufin can bring your way. For more complete information write for a free copy of the Trufin Comparison Book, from which this data was taken or, ask your Wolverine Tube salesman—HE KNOWS!

ADMIRALTY TRUFIN

For a given service the calculated bare tube cooler contains 3100 sq. ft. in a 39" ID shell. Tubes are ¾" OD x 16 BWG x 16'0" long admiralty on 1" square pitch. The shell side coefficient and fouling factor were 150 and 0.002 respectively. The tube side coefficient and fouling factor for the water were 1000 and 0.001.

From *Fig. 8*, Cost=$16,400.

Refer now to *Fig. 4*

$$\frac{1}{1/h_o + r_{do}} = \frac{1}{1/150 + 0.002} = \text{115.5 Btu/hr x sq. ft. x °F}$$

$$\frac{1}{1/h_i + r_{di}} = \frac{1}{1/1000 + 0.001} = \text{500 Btu/hr x sq. ft. x °F}$$

From *Fig. 4*, 0.59 lin. ft. of Trufin are required per foot of bare tube. There are 0.1963 sq. ft./lin. ft. of ¾" OD bare tube.

From *Table 2*, there are 0.496 sq. ft./lin. ft. of ¾" OD Admiralty Trufin.

Trufin exchanger required=3100 x $\frac{0.496}{0.1963}$ x 0.59= 4610 sq. ft.

From *Fig. 10*, nearest full shell 31" ID.

Surface=4690 sq. ft.

Cost=$13,000.

Saving=$16,400 − $13,000=$3,400.

WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
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PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES

TABLE II

	NOMINAL SIZE		PLAIN SECTION DIMENSIONS		FINNED SECTION DIMENSIONS			OUTSIDE AREA	SURFACE AREA RATIO	I.D. CROSS SECTIONAL AREA
	O.D.	CATALOG NO.	O.D.	Wall Thk.	Root Dia.	Wall Thk.	Inside Dia.	Sq. Ft. per Linear Ft.	ao/ai	In Sq. Inches
19 FINS PER INCH	3/4	60-195028	.750	.049	.625	.028	.569	.496	3.33	.254
		60-195035		.049		.035	.555		3.41	.242
		60-195042		.058		.042	.541		3.50	.230
		60-195049		.065		.049	.527		3.60	.218
		60-195065		.083		.065	.495		3.84	.192
		60-195083		.095		.083	.459		4.13	.166

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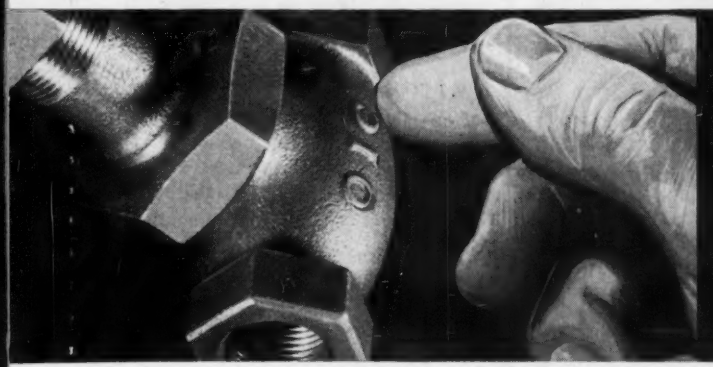

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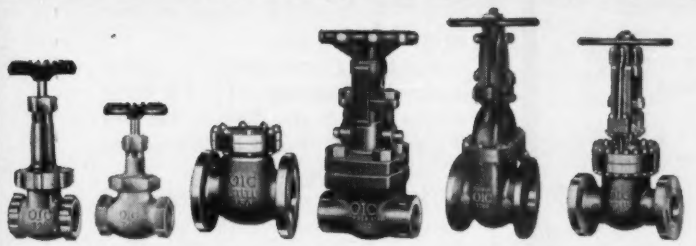

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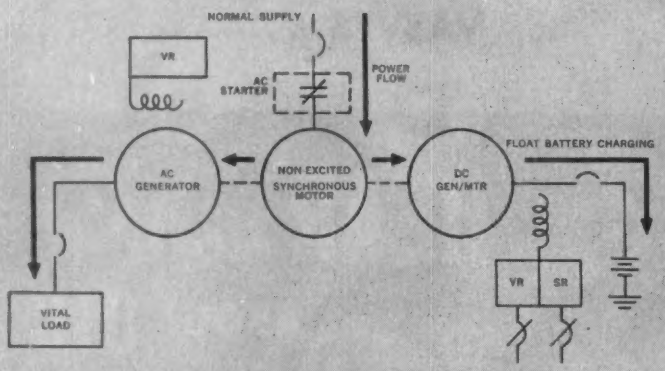
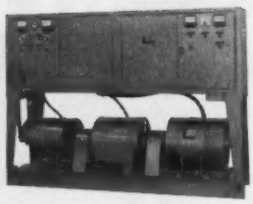


HOW A COSTLY VACCINE IS PROTECTED IN PROCESS BY A KEARFOTT UNINTERRUPTED POWER SYSTEM



The AC generator rating of this Kearfott installation is 5 KW, 3 phase, 60 cycle, 120/208 volt.

The system pictured above is typical of many which Kearfott has furnished to prevent power failures or fluctuations from affecting the fine, continuous control necessary in certain vulnerable manufacturing processes. The user, a Polio Vaccine producer, regulates virus growth with the help of infrared and radiant heat devices that cannot tolerate any loss of electrical power.

Here, a non-excited synchronous motor operated on the normal power drives both an AC and a DC generator. The output of the former is to the vital load, while that of the latter is used to maintain the batteries in fully charged condition. In the event of main power failure, the DC generator operates as a motor, drawing current from the batteries to drive the AC generator. When main power returns, the system automatically returns to normal operation. When on normal, the system maintains output to the vital load within ±1% of rated values regardless of input power supply variations.

Generator ratings to 150 KVA 60 and 400 cycles, single and polyphase. Frequency, voltage and transfer regulation as required by the application.

Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION, INC.

Little Falls, New Jersey

Marmaduke

Begins on page 154

sailing instead of abandoning ship and then planning to come back to her—if that's what they planned, and if it was saboteurs and not the ship's engineers who removed those injectors?"

"That's what I'd like to know," answered the big man, resting his tired head on one arm, "but after I checked the day fuel-oil tank and found about two feet of water in her, I decided they couldn't start the engine. Or maybe the sub was in a big hurry to take them off, if it was a sub. I drained that water into the bilges by breaking a connection down below at the fuel-injector pump. I figured someone contaminated that oil before the party got too rough—then they didn't know enough about diesels to get it started in time."

After another puff and a few smoke rings, Marmy continued, "but maybe it was the tanker's chief engineer who hid the injectors, bled out the starting air and contaminated the day tank after he heard what was going on topside. Maybe he was caught red-handed sabotaging his own ship and got bashed in the head by a shipmate for his loyalty."

"Why did they let that ship drift instead of dropping her anchor?" asked the executive officer. "They didn't need any juice to do that. Hell, that's a mighty queer way to abandon a ship you expect to salvage. She could have ended up at the North Pole, to say nothing of endangering the enemy's shipping as well as ours."

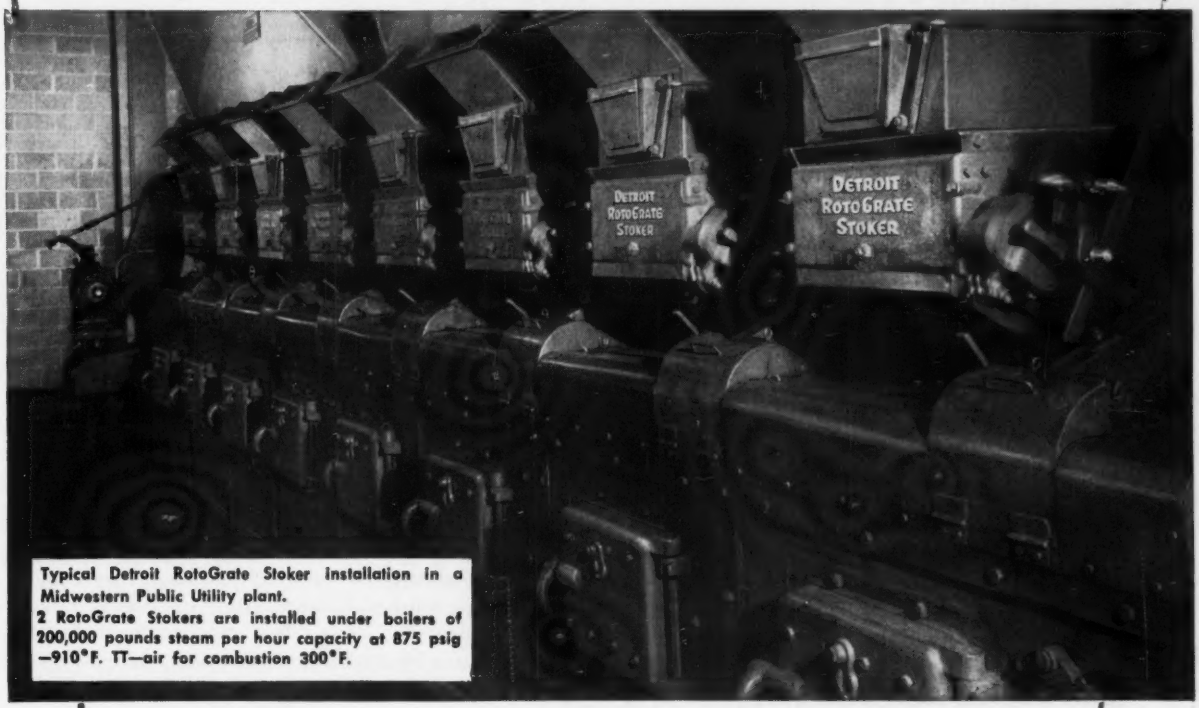
"Your guess is as good as mine," roared Marmaduke, taking another swig of black coffee.

Just then general quarters sounded again—everyone rushed to his battle station as a Stuka dove at the *Sea Witch*, raking her decks with a shower of machine-gun bullets.

The mystery of the murdered and missing crew has not been solved to this day. But engineering officer Marmaduke Surfaceblow, USNR, and his crew were commended for salvaging the loaded tanker. And Marmy did it by rigging the biggest outboard-motor cranking device in maritime history—or anywhere else, for all we know. —STEVE ELONKA

WHAT OUR CUSTOMERS *"Say"* ABOUT

Detroit ROTOGRATE STOKER Performance



Typical Detroit RotoGrate Stoker installation in a Midwestern Public Utility plant.
2 RotoGrate Stokers are installed under boilers of 200,000 pounds steam per hour capacity at 875 psig —910°F. TT—air for combustion 300°F.

Our field engineers get around—visit plants in all parts of the country and their reports tell us that users say their RotoGrate Stokers—

DO OPERATE with lower excess air—22% is common—less in many cases . . . Reason—the floating, self-adjusting air seals—a RotoGrate exclusive.

DO HANDLE load fluctuations easily . . . Sudden load increases picked up without loss of pressure—the thin fast burning fuel bed permits dropping load surges just as rapidly.

DO BURN all grades of bituminous and lignite coals, and many kinds of waste and refuse fuels . . . Ability to burn the less costly fuels available in any area is a potent factor in economical operation.

DO MAINTAIN uniform high efficiency in everyday operation. RotoGrate doesn't need special test conditions to show superior results.

DO SET a high standard of availability . . . A survey of users shows exceptional availability records in all kinds of plants.

DO OUTPERFORM other fuel burning equipment . . . Where it is possible to compare with other fuel burning equipment under similar conditions, operators almost without exception express preference for the RotoGrate.

DO SAVE . . . Low cost fuels—high efficiency—very little parasite power for operation—broad load ranges with uniform steam pressure—low maintenance—and not least important reduced production losses from outage . . . all contribute to savings that pay a handsome return on the investment.

DO YOU feel you can afford not to avail yourself of these advantages and economies for YOUR boiler plant? Why not write for bulletin 40 which describes the RotoGrate for boilers up to 400,000 pounds per hour capacity? Then let us recommend the correct stoker for your needs, without obligation of course.

Write **DETROIT STOKER COMPANY**
DIVISION OF UNITED INDUSTRIAL CORPORATION
MAIN OFFICE AND WORKS MONROE, MICHIGAN
District Offices or Representatives in Principal Cities

For more facts circle 308 on Reader Service card, p 109

Powerscope . . . A selective look at

Solar-power generator

A 5-hp solar generating unit costing $4000 can produce electricity for about 5¢ per kwhr. Dr Henry Tabor, Director of the National Physical Laboratory of the Council of Scientific Research in Tel Aviv, Israel designed the unit. It has a cylindrical collector, vapor turbine and heat accumulator. The unit has six collectors made of inflated plastic cylinders, 40-ft long and 5-ft dia, using selective black surfaces. Chlorobenzene is the turbine's vapor. The accumulator uses a salt which melts at 600 F. An auxiliary oil-fired heater is included for use during cloudy weather. The group is looking for foreign capital to mass-produce the plants. (*McGraw-Hill World News*)

Breaking 9000 Btu per kwhr

Clinch River Plant of Appalachian Power Company established a 12-month record in 1960: it's the first plant to run at an average yearly heat rate under 9000 Btu per kwhr, at an official performance of 8975 Btu per kwhr. The pulverized-coal-fired plant has two 1,523,000-lb-per-hr boilers feeding 2400-psig 1050/1050-F steam to two 237.5-mw cross-compound steam turbines. Both units started commercial operation in late '58.

Brackish-water conversion

"It seems likely that many brackish-water conversion plants will be built before sea-water conversion reaches any consequential proportions," says Fred A Loebel, President of Aqua-Chem, Inc. The vapor-compression process is cheaper with waters of 4000-ppm dissolved solids than with sea water of 35,000-ppm dissolved solids. Power saving runs about 10% and plant investment, too, would be lower. Loebel suggests a range of 1000 to 4000 ppm as defining brackish waters. He believes that 70¢ water from brackish water can be attained with vapor compression in most of the Southwest. Where dilution conditions are favorable, this would drop to 35¢ per 1000 gal. An additional 20¢ would cover cost of storage and distribution.

Record stokers in incinerator

Hamilton Avenue Incinerator Plant, Brooklyn, N.Y., has four traveling-grate stokers rated to burn 1000 tons of refuse every 24 hr. Each unit has a drying stoker and a burning stoker, 8-ft wide. The drying stoker tilts at 25 deg; it's 22-ft long; the 35-ft 3-in. burning stoker discharges decontaminated residue. Units were built by the Illinois Stoker Company and cost about $5 million installed.

Successful Swiss bid

The Los Angeles Board of Water and Power Commissioners awarded an $8.8-million contract to Brown Boveri Corp for two 200-mw turbine-generators to go in the Haynes steam plant. Lowest American bid was $10.3 million by Allis-Chalmers Mfg Co. In Feb '59 Brown Boveri successfully bid the first two Haynes units at $9.3 million. First unit is scheduled for Sept 1962 start.

Reds at it again

In commenting on an article on magnetohydrodynamics published in the Russian *Sovietskaya Litva* on March 30, 1961, Philip Sporn, President of American Electric Power Company, Inc, writes: The implication . . . is that Russian technologists are about ready to build large-scale MHD plants. It is obvious from the specific temperatures, efficiency and size quoted that the article only reports work done in this country by American engineers and reported in various places, among others in an article by Kantrowitz and Sporn in the October 1959 issue of POWER. A recent release by Tass of July 2 [contains nothing] new or Russian—[it] is part, apparently, of the same pattern of reporting to the world Russian technical achievements in electric power. This . . . seems to me to be a further example of the confusion which results in trying to appraise techniques reported in Russian technical publications: whether they are being reported as plans or accomplished achievements; and whether they are claimed as Russian or otherwise in origin.

Floating nuclear plant

Army Corps of Engineers, Philadelphia District, has awarded a $17-million contract to the Martin Company for design, construction and testing of a floating 10-mwe nuclear-power plant. It will be installed in the hull of a reconditioned Liberty ship. Right now they'll get only $664,000 for the design stage of the project—other phases will be entered at the government's option. Design must be completed in 15 months, construction and test will take an added three years. Martin's was one of eight proposals submitted. (*McGraw-Hill World News*)

this month's power-field happenings

B G A SKROTZKI, Associate Editor

Gas-turbine pipeline pumper

Phillips Pipeline Company of Oklahoma has ordered an 1100-hp gas turbine to drive a liquid-products pump in its pipeline operations. The 2-shaft diesel-fuel-burning unit will be used to boost pressures at various sites on the line. A Solar Aircraft Company turbine, driving a Carter pump, will be only 98-in. long, a portability advantage over the 178-in. units now used by Phillips. The turbine pumps butane, propane and other liquids at a rate of 1900 gpm at 2500-ft head.

Starting salaries up

Illinois Institute of Technology in Chicago reports that its 1961 graduates received about 5% higher starting salaries than the 1960 grads. Here's the comparison by specialties: metallurgical engineers, $590 monthly vs $520; electrical engineers, $566 vs $544; chemical engineers, $548 vs $530; industrial engineers, $542 vs $493; mechanical engineers, $537 vs $520; civil engineers, $531 vs $510.

Control for Paradise

TVA will use two digital computers to control its Paradise Station Units 1 and 2. The TRW Computers Company units will be used with Republic Flow Meters combustion controls. The system will automatically control the turbine generators, sequence-monitor the steam generators. It will sequence cold start, hot restart, normal shutdown or emergency shutdown of the main equipment. The system will scan sensors and do alarm monitoring. It will log data, record trends and calculate performance.

Two-million mark

During July, Pacific Gas & Electric Company of Calif. connected its 2-millionth electric customer into its extensive system. The 1-millionth customer was connected in 1943; at present, they are connecting about 5000 new customers every month. PG&E also has 1,705,000 gas customers and a sprinkling of steam and water users.

Two-way deal

Shawinigan Chemicals Limited of Montreal, Canada, plans building a $20-million petrochemical plant at the same time Shawinigan Water and Power Company starts an associated $45-million 300-mw steam plant on the south shore of the St. Lawrence River. Chemical plant is scheduled for a mid-1963 start and first 150-mw unit in the power plant is scheduled for mid-'64 with the second unit a year later. British American Oil Company Ltd will process crude oil to provide raw materials for the petrochemical plant and heavy fuel oil for the steam station. Petrochemical plant's output: ethylene, propylene and other products.

Seven sins of weighing

Scale Manufacturers Association estimates that hundreds of millions of dollars are lost annually through mistakes in weighing accuracy. The seven most common sins are: (1) neglect and maltreatment (2) using wrong scale for job (3) improperly installing scale (4) lack of level and sturdy support for small scales (5) infrequent testing of scales (6) lack of maintenance (7) poorly trained operators.

Prosperity and energy

United Nations Energy Conference in Rome, Italy looked at new sources of energy. A paper by M S Thacker of New Delhi, India made this comparison:

Country	*Annual income per capita, $*	*Equivalent coal use, tons per capita-year*
U.S.A.	2070	8.6
U.K.	904	5.0
West Germany	640	3.6
Netherlands	620	2.5
Italy	385	1.1
Japan	230	1.1
India	51	0.1

Hawaiian peaking unit

First peaking diesel unit for the state of Hawaii is under construction by Fairbanks, Morse & Company. The Hilo Electric Light Co, Ltd unit will deliver 2 mw within 90 seconds from a cold start. A 12-cylinder self-contained set, it's slated for November installation. All switchgear and controls are housed in a separate waterproof cubicle, skidmounted like the engine for portability. The unit will start (and stop) automatically on power failure or predetermined voltage drop. The set will be 65 miles from the main plant at Naalehu, and will be controlled manually from a remote station on the feeder lines at first.

New Conveyor Design

—cuts maintenance!
—extends belt life!

Here is a new and entirely different type of belt conveyor. The secret of its amazingly improved efficiency is in the cradle idler, which consists of 5" rubber rollers, assembled on precision-ground ball bearings, prelubricated, and lifetime sealed. The rollers are suspended in a true catenary on flexible, nonrotating stainless steel wire rope, which cannot corrode. Because the wire rope does not rotate, it cannot twist and cause loping, dangerous harmonics, and undue belt wear.

The wire rope is supported at each end by a simple ball joint, so it is free to move in any direction, permitting the belt to adjust itself to any profile. The true catenary suspension provides uniform belt support without bends or creases. *Thus belt life is substantially increased.*

Write Today for Complete Information

McNALLY · PITTSBURG

McNally Pittsburg Mfg. Corp.
Dept. PO, Pittsburg, Kansas

☐ Please send information on the new McNally Pittsburg belt conveyor.

☐ Have Sales Engineer call for further consultation.

Name_____ Title_____

Company_____

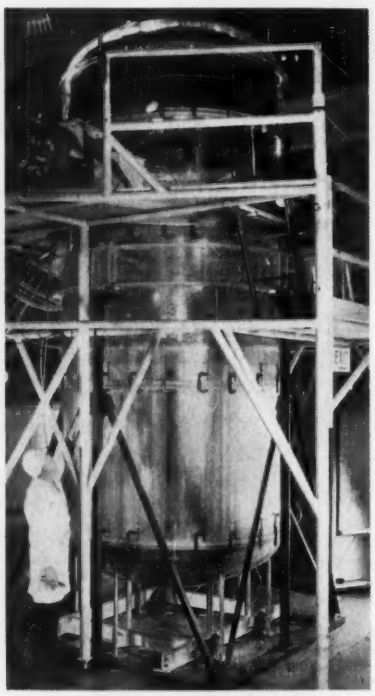
Address_____

City_____ State_____

Volcano may provide power source

Honolulu *(McGraw-Hill World News)* The Magma Power Company of Los Angeles and the newly organized Hawaii Thermal Power Company will start drilling soon for volcanic steam as a possible power source in Hawaii.

Drilling will be in the area of recent eruptions of Kilauea Volcano. Goal: tap a steam source that will supply power for the city of Hilo and Hawaii island cheaper than the power created presently by burning oil.



Reactor model simulates gas flow

A transparent 5-ton half-size model helps engineers simulate gas flow of a full-sized gas-cooled reactor at General Dynamics Corporation, General Atomic Div. Helium-cooled 40,000-kw graphite-moderated reactor is being developed by General Atomic at Peach Bottom, Pa. for the Philadelphia Electric Company and 52 utilities of the High Temperature Reactor Development Associates.

Model contains dummy aluminum fuel elements. Four Plexiglas shells

Begins on page 166

duplicate reactor's shields. From a control console, engineers can conduct heat-transfer experiments, apply controlled heat to patch thermocouples and read temperatures under varying gas flow. Manometers transmit pressure information from significant points in flow path. Flow is observed through model's transparent walls. Adding smoke to incoming air changes flow rates, paths and pressures to simulate situations expected in the prototype 35 ½-ft-high reactor vessel.

Computer runs Little Gypsy safely and efficiently

New Orleans *(McGraw-Hill World News)* Louisiana Power and Light Company's Little Gypsy Plant went into commercial operation last March. This first steam-electric unit capable of fully automatic operation (POWER, May '59, pp 64 to 65) is capable of generating 230,000 kw—with future units, an anticipated 2,000,000 kw.

The electronic computer-control system will not eliminate human operators. The normal complement for a single unit—three operators—will be necessary. The station also requires engineers and maintenance personnel. But greater plant control efficiency and safety and faster decision-making is possible without the liability of human error. The computer will monitor continuously about 700 temperatures, pressures, flow rates and valve and switch positions. If it gets confused, it resigns and turns the unit over to human hands in a semi-automatic condition. It will be accepting commands to decrease or increase power output from the Middle South Utilities system operator center at Pine Bluff, Ark.

Moscow *(McGraw-Hill World News)* Konakov Thermoelectric Station in Moscow, which the Soviets claim will be the world's largest, will operate on natural gas. Highly automated plant will be assembled at the site from prefabricated reinforced-concrete columns and preassembled parts. It is slated for completion in early 1963.

continued

AMF

POWER TRANSIENT ANALYZER

RUGGED • PORTABLE

Here is an instrument designed to conveniently measure and record simultaneously to a high degree of accuracy, transient values of voltage, current and frequency in three-phase power systems. Output is displayed through a recorder using string galvanometers and a light-sensitive paper requiring no chemical processing for development. For field application, this analyzer is unexcelled in analyzing engine-generator sets, motor-generator sets, aircraft generators and commercial power sources. It is useful as a maintenance tool in the alignment of governors, generators, engines, voltage regulators and composite power plants, in field testing and for measuring input power to determine equipment susceptibility to variation and modulation of frequency and voltage. It is completely documented in the Federal Supply System as the "Analyzer Set, Engine Generator, AN/USM-86(A)".

FOR TESTING AND MAINTENANCE OF:

- Airborne Electrical Equipment
- Alternators
- Antenna Support Equipment
- Converters
- Generators
- Ground Support Equipment
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- Motors
- Power Supplies
- Radar Systems
- Relays and Contactors
- Switches
- Transformers

Send now for illustrated brochure which gives more detailed information.

AMF

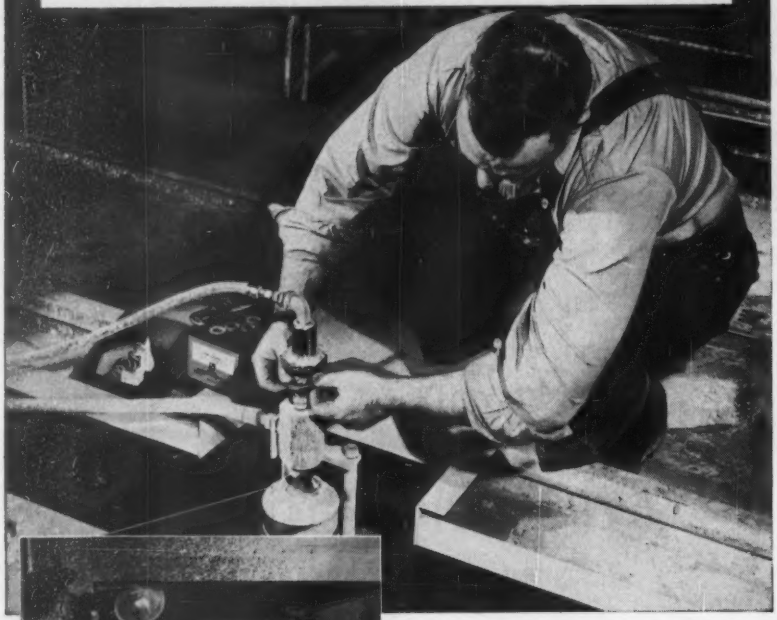
AMERICAN MACHINE & FOUNDRY COMPANY

1101-G North Royal Street, Alexandria, Virginia

Executive Offices 261 Madison Avenue, New York 16, N. Y.

For more facts circle 310 on Reader Service card, p 109

How SEVENeering with R/M eliminated costly packing replacement problem on revolving head spray machine



Switch to new R/M No. 363 Packing Rings increased packing life up to 500%

Poor packing life once was a major cause of a spray painting problem on the acoustical tile production-line at Wood Conversion Company, Cloquet, Minn. The packings in the revolving head spray machines required frequent takeup, were damaged by the water-soluble clay and latex paint, failed in 5-7 days.

In the search for better packings, Wood Conversion Company consulted Modern Distributors, Duluth, Minn., an authorized R/M distributor. R/M No. 363, a new braided asbestos packing with a neutral, graphite-free lubricant, recently introduced by R/M, was recommended. Following tests in its own plant, the company adopted this packing, and with outstanding results.

Packing life has increased as much as 500%, fewer adjustments are needed, shafts wear longer. To sum it up: An R/M packing that costs less than the one it replaced has not only solved a vexatious problem for Wood Conversion Company, but has also brought the big positive advantage of more profitable operations.

The company has been using R/M packings for a number of critical applications, all with complete success.

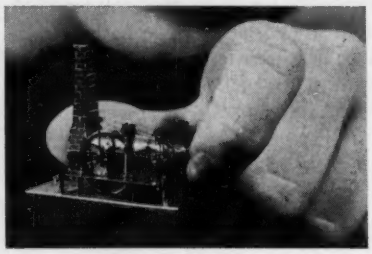
Call in your nearby authorized R/M packing distributor to help you solve your packing problems. R/M No. 363 may not be the answer in your case, but you can be sure he stocks the right packing to fill your requirements. Learn more about SEVENeering with R/M . . . ask your distributor for a copy of the new R/M Big 7 Packing Selection Chart today.

R/M's Big 7 Packing Types meet 95% of all packing needs, are sold exclusively through authorized R/M distributors

RAYBESTOS-MANHATTAN, INC.
BIG 7 PACKINGS
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

Powerscope

Begins on page 166



Tiny steam engine is on display

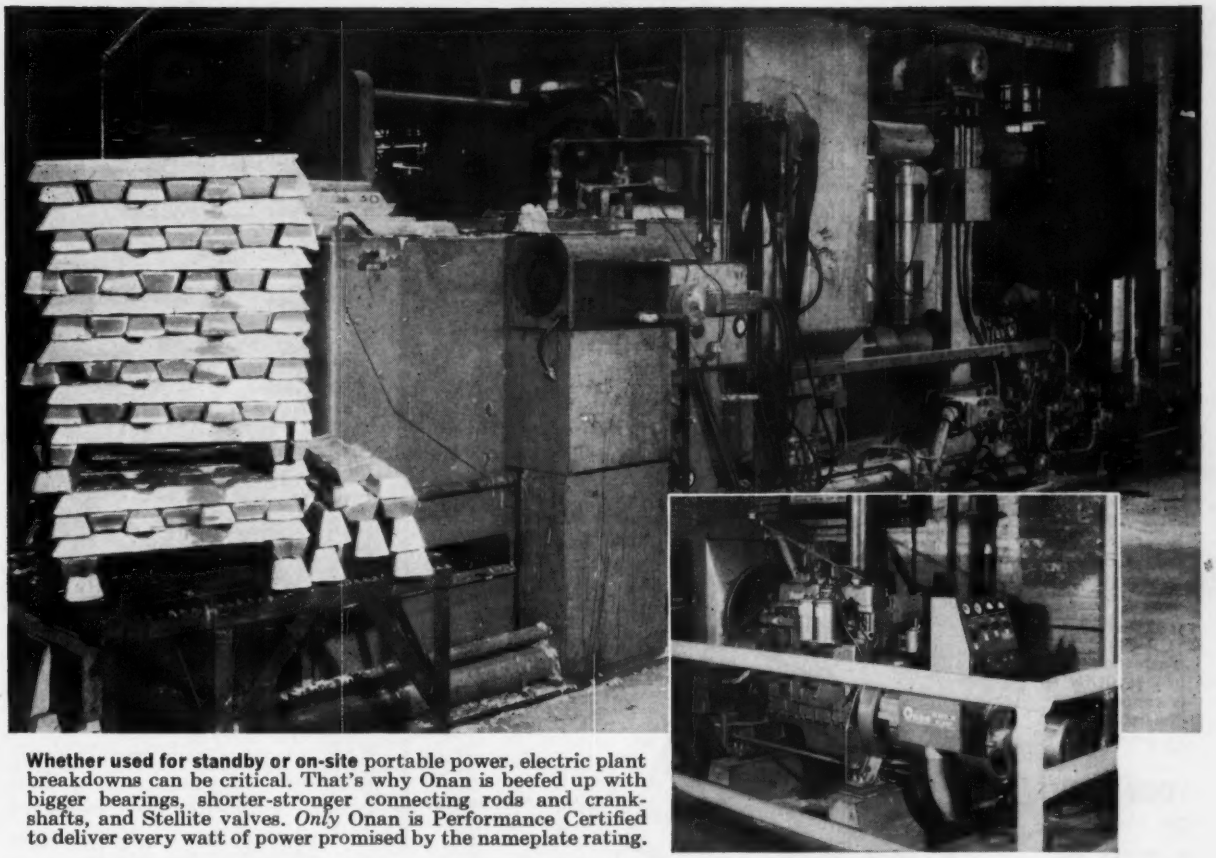
This Lilliputian engine, the smallest operating steam engine ever built, was made from gold and silver in 1849 by a 16-yr old boy, Cyrus Chambers Jr. Weighing less than half an ounce, it has a 1/16-in. cylinder and 3/16-in. stroke. Maximum speed is 3000 rpm. The engine, new addition at The Franklin Institute Science Museum, was a major attraction at the Philadelphia Centennial Exposition in 1876 where it was exhibited in contrast to the Corliss engine, the most powerful constructed to that time.

Flash evaporator shipped to TVA

Westinghouse Electric Corporation has transported a single-stage flash evaporator by rail to the Tennessee Valley Authority's Paradise Steam Station in Kentucky. It is capable of producing over 70,000 lb per hr—200,000 gpd—of high-purity boiler-feed makeup from river water. Completely factory-assembled and hydrotested beforehand, flash evaporator is largest ever shipped in the U. S.—a mate will join it shortly.

Beacon to shine at World's Fair

A tower of light expected to be visible from as far away as Boston, Mass. and Washington, D.C. will be part of the investor-owned electric-utility companies' exhibit at the 1964-'65 World's Fair. The 24-billion-cp beacon will be based in a building 80-ft high located on the main-entrance traffic artery to the Fair. A moving ramp will take visitors to the top



Whether used for standby or on-site portable power, electric plant breakdowns can be critical. That's why Onan is beefed up with bigger bearings, shorter-stronger connecting rods and crankshafts, and Stellite valves. *Only* Onan is Performance Certified to deliver every watt of power promised by the nameplate rating.

Only Onan is certified to give you all the power promised by its nameplate

It's a fact that many electric plants on the market today do not deliver the output promised by their nameplate rating.

Every Onan plant is given a rugged workout *under full load* before it is shipped—*your assurance* that the Onan you buy is ready for hard work the day you get it.

But this isn't enough. Independent laboratory inspectors pull surprise inspections to double-check our tests and testing methods. They pull a plant off the line, run it, stop it, load it, overload it, check and recheck. Their torture test gives positive proof of Onan's quality. End result: *Onan's exclusive Performance Certification* . . . your assurance of getting every watt of power you pay for.

So when you're tempted by an electric plant "bargain," make sure its nameplate rating is not "inflated." Be sure you're getting full measure for your money. Remember, *the electric plant that shortchanges you in power output is no bargain at any price!* Only Onan is Performance Certified to deliver everything the nameplate promises.

See Onan electric plants soon. Compare before you buy. You'll find your Onan distributor listed in the Yellow Pages. Call him or write direct.

PERFORMANCE CERTIFIED
We certify that when properly installed and operated this Onan electric plant will deliver the full power and the voltage and frequency regulation promised by its nameplate and published specifications. This plant has undergone several hours of running-in and testing under realistic load conditions, in accordance with procedures certified by an independent testing laboratory.
Onan
World's Leading Builder of Electric Power Plants

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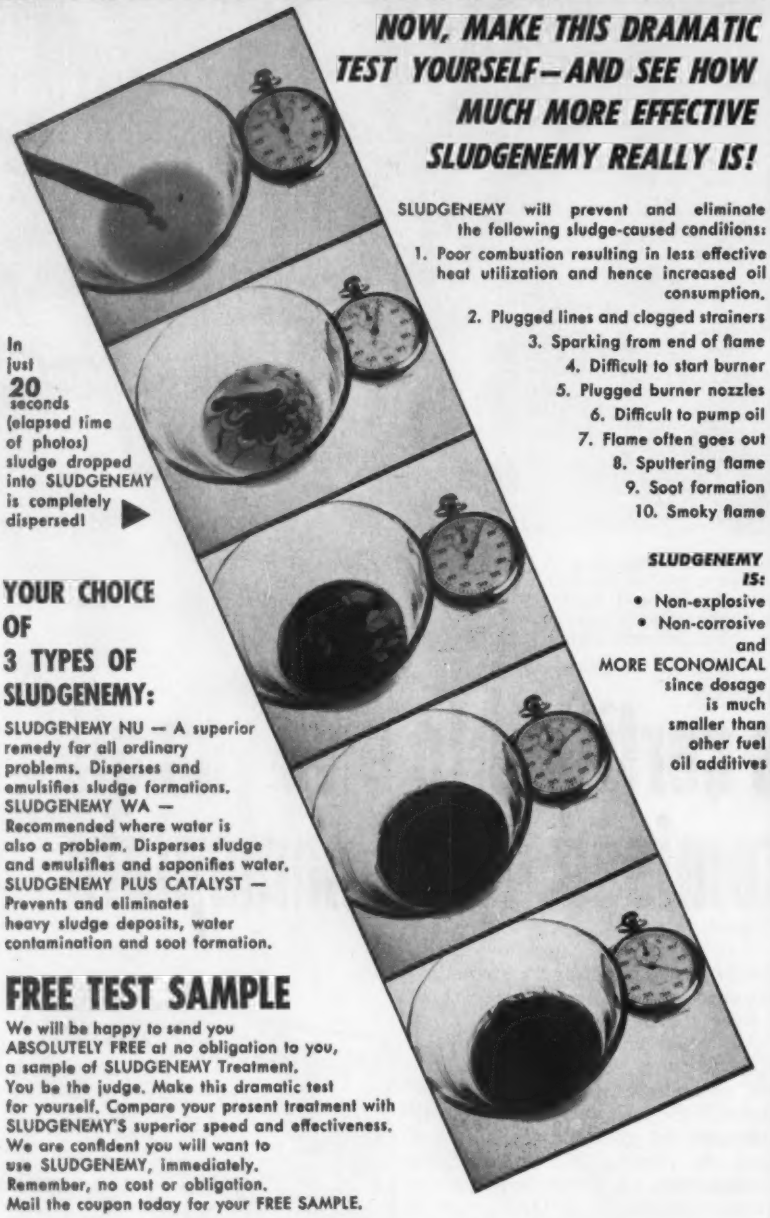
ONAN Division, Studebaker-Packard Corporation, 2683 University Ave. S. E., Minneapolis 14, Minn.

For more facts circle 312 on Reader Service card, p 109

ELIMINATE SLUDGE in Fuel Oil Much Faster, More Completely!



In just 20 seconds (elapsed time of photos) sludge dropped into SLUDGENEMY is completely dispersed!

NOW, MAKE THIS DRAMATIC TEST YOURSELF—AND SEE HOW MUCH MORE EFFECTIVE SLUDGENEMY REALLY IS!

SLUDGENEMY will prevent and eliminate the following sludge-caused conditions:

1. Poor combustion resulting in less effective heat utilization and hence increased oil consumption.
2. Plugged lines and clogged strainers
3. Sparking from end of flame
4. Difficult to start burner
5. Plugged burner nozzles
6. Difficult to pump oil
7. Flame often goes out
8. Sputtering flame
9. Soot formation
10. Smoky flame

SLUDGENEMY IS:
- Non-explosive
- Non-corrosive

and MORE ECONOMICAL since dosage is much smaller than other fuel oil additives

YOUR CHOICE OF 3 TYPES OF SLUDGENEMY:

SLUDGENEMY NU — A superior remedy for all ordinary problems. Disperses and emulsifies sludge formations.
SLUDGENEMY WA — Recommended where water is also a problem. Disperses sludge and emulsifies and saponifies water.
SLUDGENEMY PLUS CATALYST — Prevents and eliminates heavy sludge deposits, water contamination and soot formation.

FREE TEST SAMPLE

We will be happy to send you ABSOLUTELY FREE at no obligation to you, a sample of SLUDGENEMY Treatment. You be the judge. Make this dramatic test for yourself. Compare your present treatment with SLUDGENEMY'S superior speed and effectiveness. We are confident you will want to use SLUDGENEMY, immediately. Remember, no cost or obligation. Mail the coupon today for your FREE SAMPLE.

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Please send:
- ☐ FREE sample of SLUDGENEMY. I would like to take advantage of your free test offer.
- ☐ More details on the SLUDGENEMY Program.
- ☐ Information on other UNIVERSAL products.

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Refining Products Co., Inc.
40 Years of Service to Industry

SCALENEMY, SLAGENEMY, SLUDGENEMY, KILLRUST, STEAM AND RETURN LINE TREATMENT and other fine industrial chemicals.

Powerscope

Begins on page 166

floor. From there they will begin a spiral walk downward, viewing electric-industry displays.

Air-conditioned Alamo

Artfully camouflaged General Electric Company heat pumps have made it possible to turn the clock backward at the Alamo. Steam radiators, pipes and large paddle-blade fans have been stripped from the interior walls, leaving them much as they were back in 1836 during the Battle of the Alamo.

The pumps keep the temperature comfortable for visitors the year 'round. But installation presented problems—how to put the equipment in without adding a modern note to the old structure, how to comfortably heat and cool the high-ceiling building and get adequate capacity to cope with thick stone walls that couldn't be insulated.

A pair of pumps was concealed on the roof behind a parapet pocked by Mexican musketballs. Newly opened choir lofts, last used before 1793 when the Alamo, originally a church, was secularized, hold supply outlets for the air-handling units—heavy-iron window grilles disguise the outlets. A 5-ton heat pump is camouflaged in a small stockade made of cedar posts.

Army corps of engineers has awarded a $600,000 contract to Consolidated Diesel Electric Corp for portable diesel-engine-driven electric-generator sets. Each of 116 units will provide 45 kw of 60-c ac power. Sets will be winterized for arctic operation.

continued

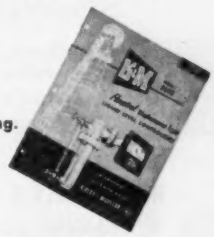
• • • "Frictionless" design gives Flexotrol* longest life, stability and accuracy of any displacement level controller

By avoiding knife edges, bearings and associated pressure-tight mechanical fittings, K & M has achieved almost frictionless operation in the *Flexotrol* Displacement-Type Liquid Level Controller. As a result, errors due to friction, distortion and hysteresis are practically nil.

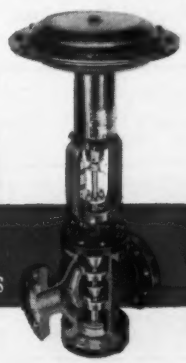
Actuation is accomplished through a torque element which directly transfers displacer movement to the controller. There are no intermediate levers. Because the rotation of the tube is limited (4°) and because the whole assembly is constructed of high-durability materials, the torque system has remarkable fatigue resistance. Tests in excess of five million operating cycles have produced no detrimental fatigue effect.

The controller unit utilizes conventional 3-15 psi signal air pressure, has a 0-150% adjustable proportional band, may be direct-, reverse- or snap-acting without parts change. The *Flexotrol* Level Controller can also be converted to a transmitter-controller combination. Automatic reset and rate response are optionally available.

Full details are given in Bulletin 456-1. A copy is yours for the asking.



*Flexotrol is a trade-name of Kieley & Mueller, Inc.



K&M

diaphragm control valves

Our 80th Year

KIELEY & MUELLER, INCORPORATED

Oldest Pressure and Level Control Valve Manufacturer

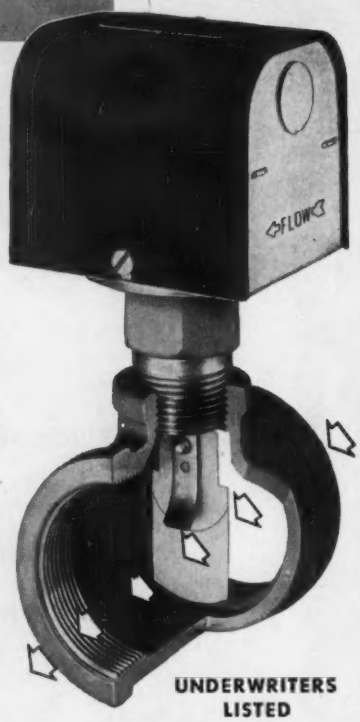
64 Genung Street, Middletown, New York

B.A. 1935

For more facts circle 314 on Reader Service card, p 109

McDONNELL *Flow Switches*

FS4 Series Flow Switch shown mounted in a 2 inch Tee

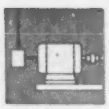


Here's what they do!

What you see here is a compact, well-built switch that makes or breaks a circuit (as required) when liquid flows or stops flowing. It's an economical and positive way to start or stop anything electrically operated. Just to highlight a few uses:

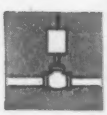
to actuate a signal light—signal an attendant to make the right moves in operating valves, pumps and the like—signal him when flow stops in a water cooled compressor, water cooled bearing and so on.

to sound an alarm—when flow stops in a process system or in any water cooled devices.



to start or stop motors—start pumps in sequence in multiple stage flow systems; start standby pumps; stop automatically controlled units if cooling water system fails; stop compressors in cooling systems when flow stops.

to start or stop automatic burners—start a booster heater when water draw occurs, stop burner if flow is improperly retarded; make sure of circulation in a boiler before burner is permitted to start.



to actuate metering device—open valve in chemical feeder line; start mixing in secondary line whenever flow starts in primary line.

UNDERWRITERS LISTED

Positive snap action switch. Easy to install and wire. Segmented paddle fits any pipe from 1" through 3". Unit shown handles pressures to 100 psi, temperatures to 300° F., in these types:

FS4-3—SPDT switch. Opens and closes two separate circuits with flow; closes and opens same two circuits with no flow.

FS4—Closes with flow; opens with no flow.

FS4R—Opens with flow; closes with no flow.

NOTE: Model E-2 available for larger pipes, pressures to 150 psi.

McDONNELL & MILLER, *Inc.*
3506 N. Spaulding Ave., Chicago 18, Ill.

Doing One Thing Well

Coupon brings bulletin

—covering design, construction, electrical ratings, dimensions, typical applications.

Please send me a copy of Flow Switch Bulletin FS1-A.

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By_____

Mail to: McDonnell & Miller, Inc., 3506 N. Spaulding Ave., Chicago 18, Ill.

Powerscope

Begins on page 166

Europeans take a look at our electric systems

A group of 27 European electric-utility executives from 13 countries visited the U.S. recently. Their aim was to inspect and study some major interconnections of electric power systems. The tour, sponsored by the Organization for European Economic Cooperation, visited systems in all areas of the country. Development and supply of energy is a key factor in the economy of the Western European countries.

Much of the electric capability in the U. S. is now interconnected. Utilities have been developing huge power pools through which they can coordinate their operations to best meet combined load requirements. The demand for electricity in the U. S. doubles about every ten years, virtually forcing the utilities to hang together.

Cable link makes hydropower interchange possible

Bonn *(McGraw-Hill World News)* West German power utility companies and Scandinavian power-supply corporations are negotiating to lay a 380-kv submarine cable linking their power grids.

They're discussing two plans. The most probable foresees a submarine cable from Hälsingborg, Sweden to the north of Copenhagen, Denmark. From here it would run across the Danish island of Zealand, go underwater to the Isle of Fyn and across to the European mainland via Jutland.

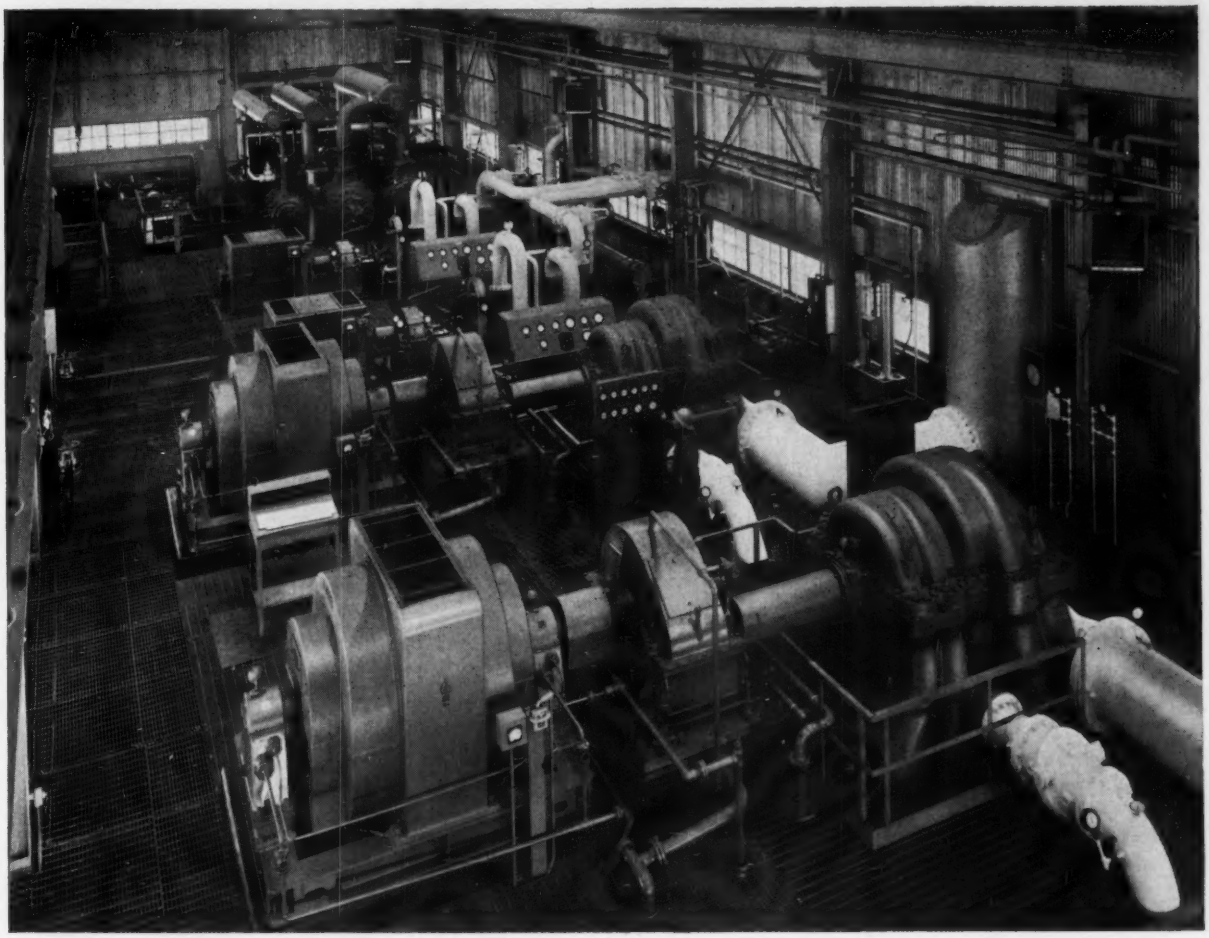
The link would allow Sweden and Norway to export surplus hydroelectric power during their long rainy and thaw seasons. In the dry season, Scandinavian utilities would receive power generated in West Germany's coal-burning stations.

The Shawinigan Water and Power Company is building a hydro plant this summer, at Rapide des Coeurs on the St. Maurice River in Canada. The $44-million plant will have 125,000-kw initial capacity.

continued

NEW CENTRIFUGAL AIR COMPRESSORS BY CLARK

The plus factor in modern oxygen plants for steelmaking



One good reason why so much U. S. oxygen capacity for steelmaking is handled by Clark compressors, is the ability of Clark engineers to develop complete compressor systems.

A typical steel mill oxygen plant installation is pictured above. In addition to being equipped with four proven Clark centrifugal oxygen compressors and a non-lube reciprocating unit handling nitrogen, this plant uses the new Clark *IsoTemp* centrifugal air compressor. Two of these machines are shown handling "100 lb. air" in the first stage of air separation.

Twenty-five *IsoTemp* compressors have been purchased for installation throughout the world after a careful analysis of features by informed U. S. and European engineers. Among the factors which influenced their choice: Four-stage, isothermal type design; the use of integral base-mounted intercoolers between each compression stage for maximum efficiency; low installation cost as a result of compact design; isolated bearing chambers combined with a unique seal porting system to eliminate lube oil contamination of the compressed air stream.

The user's confidence in the reliability of the new Clark *IsoTemp* is well founded. These machines have met all predicted performance guarantees and have proved trouble-free in every respect.

Clark Bros. Co. has unusually broad experience in the manufacture of all types and sizes of centrifugal and reciprocating compressors. If you are considering expansion, let Clark engineers help you plan for the most profit.

For further information, contact our nearest office or write to:

CLARK BROS. CO. OLEAN, N.Y.

CLARK® Engines, Compressors, Gas Turbines

Working together in allied industries . . .

PODBIELNIAK Centrifugal Contactors, Distillation Apparatus, Instrumentation

CLARK® DRESSER INDUSTRIES INC.

OIL • GAS • CHEMICAL
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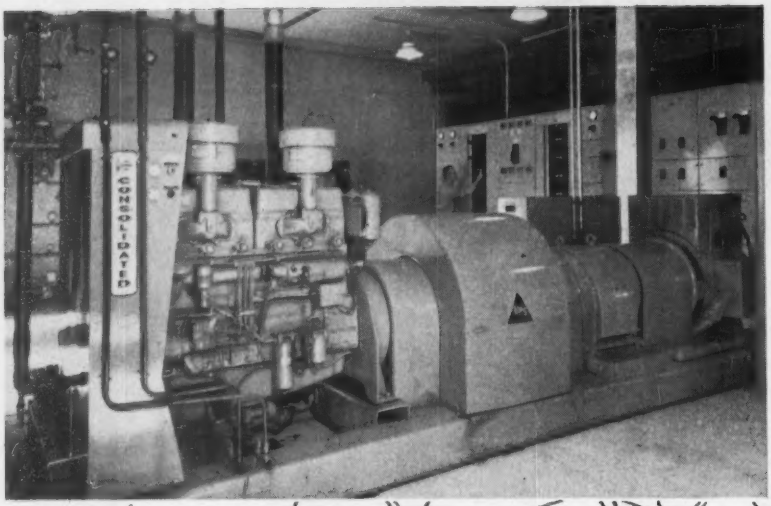
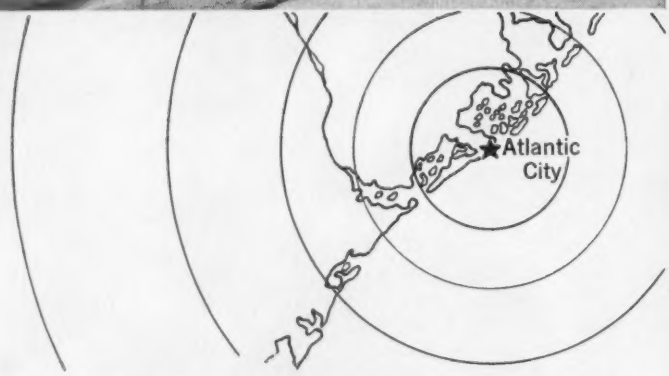




Condec UPS Selected by FAA for Use in New Experimental Air Traffic System

A new concept of air traffic control is now being tested by the Federal Aviation Agency in an experimental electronic system installed in Atlantic City. With flight plans for planes aloft over the United States or enroute to the United States stored in its mammoth memory, the computer system constantly analyzes and updates position reports to warn of collision possibilities.

At jet speeds the pattern changes with such rapidity that even a few seconds' loss of power is intolerable. Because the Condec Uninterrupted Power Supply eliminates power outages when commercial power fails, it has been chosen by the FAA to participate in the test.

If power loss for a few seconds or even microseconds can spell calamity in your operation, a Condec Uninterrupted Power Supply may be your cheapest form of insurance. It prevents power outages entirely.

For full information, write or call Mr. Frank Cesario, DAvis 5-2261, DDD Code 203.

Uninterrupted Power Supplies

Condec Uninterrupted Power Supply is a complete, packaged system for assuring absolute continuity of electrical power.

- two types — single dynamo and motor-generator
- 5 to 200 kw capacity
- full power without interruption to load
- maintains voltage within 2%; eliminates voltage regulators at load
- frequency maintained within 3.5% during transition

POWER EQUIPMENT DIVISION

CONSOLIDATED DIESEL ELECTRIC CORPORATION

STAMFORD, CONN.

A Member of The Condec Group

Powerscope

Begins on page 166

No need for conventional boilers?

Vienna *(McGraw-Hill World News)* A scheme for a power station using steam and natural-gas mixture to drive a rotating turbine was described in a Rumanian technical weekly. Station was designed by the Siberian Branch of the U.S.S.R. Academy of Sciences—but as to whether such a plant actually has been built, the magazine gave no clue.

Natural gas is burned in the combustion chamber at 995.4 psi. Low-temperature steam is injected continuously into the chamber where it heats up to 1292 F. When steam and burnt natural gas reach temperature equilibrium, heating ends.

Mixture enters turbine housing, then recuperation stage. At this point it is cooled to between 176 and 212 F. Steam for new power cycle is gained from recuperation unit, a steamer unit or from combustion chamber's heated walls. Compressors are small; they serve only to maintain equal pressure inside chamber.

Unit has 200,000-kw capacity, operating on natural gas and steam: 40.1% higher output than a comparable steam turbine, according to the weekly. Unlike a steam station, there are no conventional boilers.

Zurich *(McGraw-Hill World News)* The increasing amount of refuse from combustible garbage has prompted plans for a large power station in Munich, West Germany. Burning the present refuse will save about 40,000 tons of coal and yield a supply of 6500 kw annually. Erection of the $13½-million electric station is scheduled to start this year.

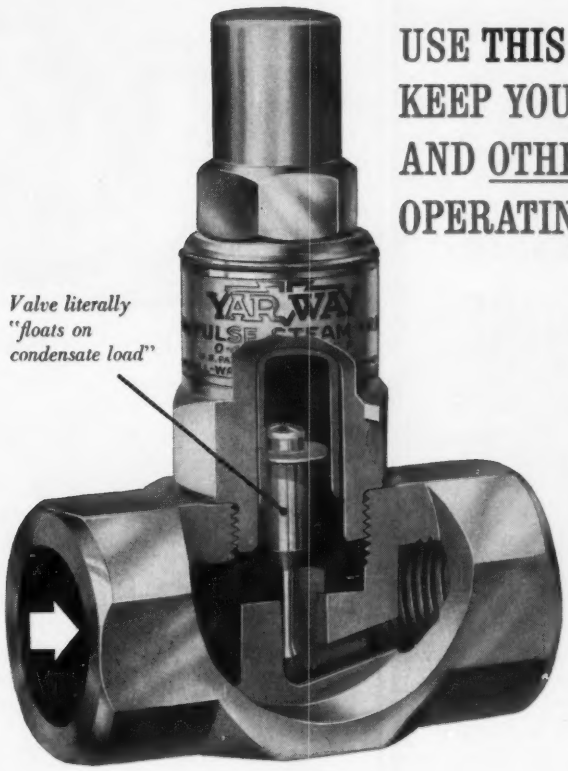
Moscow *(McGraw-Hill World News)* Power-Station Construction Minister Ignaty Novikov made it clear at a Moscow meeting of power engineers that the Soviet Union will continue to give priority to thermal power plants rather than hydro to save time in generating electricity. During the current 7-Year Plan, 1959 to '65, the Soviets plan to commission 15-million kw of power-generating capacity.

continued

YARWAY Y news briefs

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD
STEAM TRAPS STOCKED AND SOLD BY 270 LOCAL INDUSTRIAL DISTRIBUTORS



Valve literally "floats on condensate load"

USE THIS YARWAY STEAM TRAP TO KEEP YOUR DRYERS, COOKERS, TANK COILS AND OTHER PROCESSING EQUIPMENT OPERATING AT PEAK EFFICIENCY

Yarway Series 60 Impulse Steam Traps are the traps "designed with high production in mind." They get processing equipment hotter, sooner—and keep it hot. Here's how:

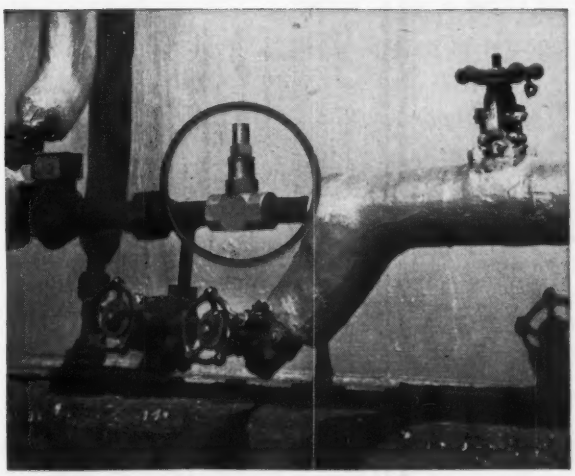
The only moving part, a small stainless steel valve, literally "floats on the condensate load." When equipment is started up, and condensate load is heavy, it opens wide and discharges at full capacity to bring equipment to operating temperature as quickly as possible.

In operation, it continuously senses condensate temperature, discharging each bit of condensate as it forms instead of storing up a bucketful. Result—higher temperatures, more even temperatures, more productive equipment.

Other Yarway features—small size, light weight, good for all pressures, low maintenance, stainless steel.

Yarway pioneered the impulse trap with its unique thermo-dynamic principle over 25 years ago. Most users find among Yarway's full line of impulse traps the profitable and productive solution to their steam trapping problems—you can too!

You can get Yarway's latest steam trap Bulletin T-1743, or a free 60-day trial of any Yarway Steam Trap, by writing Yarnall-Waring Company or contacting your local Industrial Distributor.



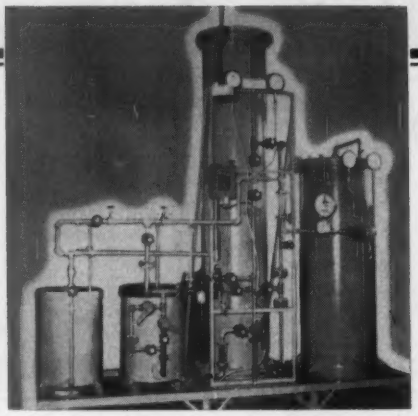
¾" Yarway Impulse Steam Trap draining tank coils on sulfur storage tank, 175 lbs. pressure

YARWAY OFFERS IMPULSE STEAM TRAPS FOR THESE SPECIFIC OPERATING CONDITIONS

AVERAGE CONDENSATE LOADS	EXTRA HEAVY CONDENSATE LOADS	LIGHT CONDENSATE LOADS
Series 60	Series 40	No. 30

For more facts circle 318 on Reader Service card, p 109

NEW FROM H&T



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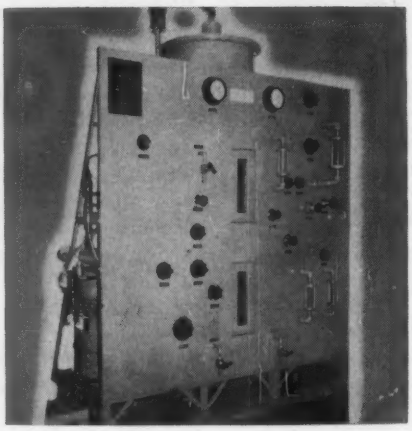


Two-Bed and Un-A-Bed STANDARD UNITS NOW AVAILABLE!!

Unless special conditions require you to use a special demineralizing system, you can save big money—and get excellent results—with the new H & T standard "PACKAGE" DEMINERALIZER! Into these superior Standard Units, we've put the experience of 16 years in building many hundreds of manual and automatic demineralizing systems.

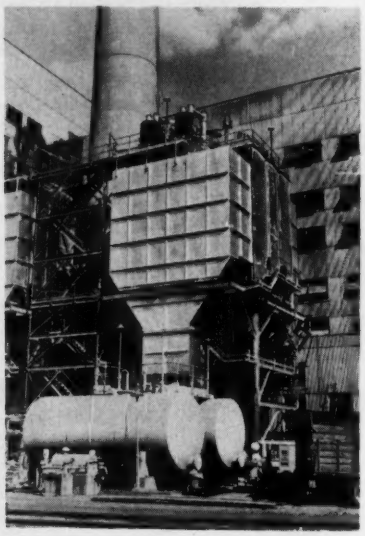
Result: H&T "PACKAGE" DEMINERALIZERS are masterpieces of design and construction—unequalled in performance and wonderfully low in cost.

Write for details of Two-Bed and Un-A-Bed Demineralizers

HUNGERFORD & TERRY, INC.
CLAYTON 3, NEW JERSEY

Powerscope

Begins on page 166



Precipitators keep gas clean at Seward Station

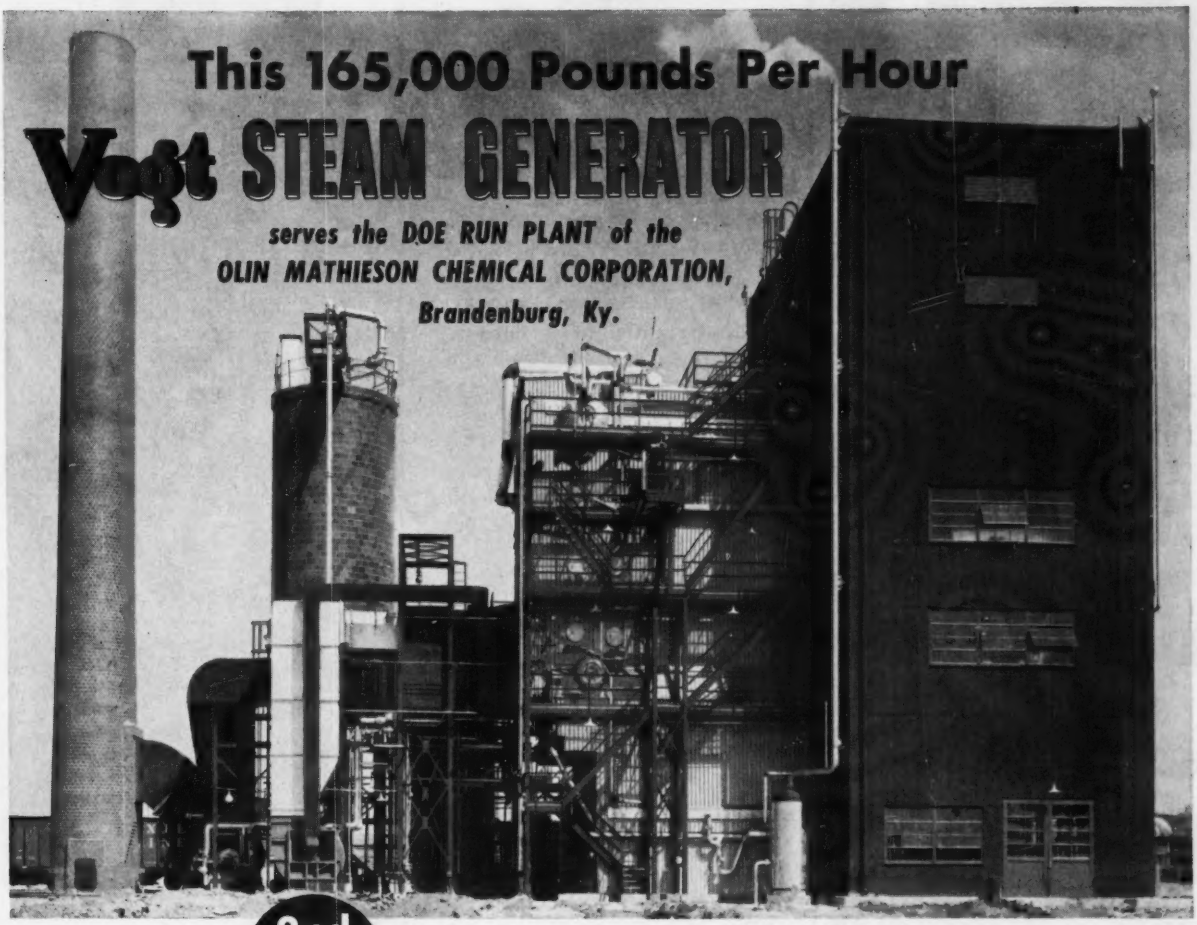
High gas-cleaning efficiency—99%—was recorded by Pennsylvania Electric Company in recent tests at its Seward Generating Station. Two electrical precipitators remove more than 100 tons of fine flyash daily. The two smoke-cleaning units are designed to handle 360,000 cfm of boiler waste gases. Mechanical dust collectors take care of the larger particles before gases enter the precipitators.

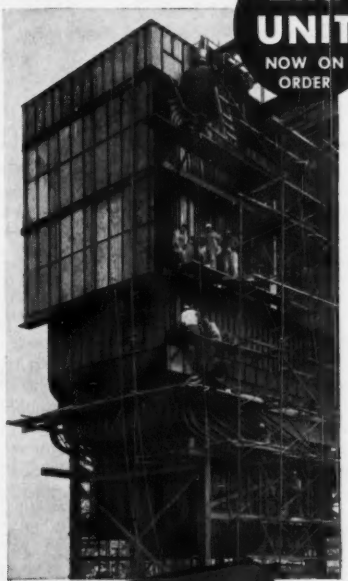
Pulverized-coal-fired boilers No. 12 and 14 at Seward produce 600,000 lb per hr of steam to drive a 51,700-kw turbine. Equipment purchased for smoke control at the Station cost over $2,000,000.

This 165,000 Pounds Per Hour

Vogt STEAM GENERATOR

serves the DOE RUN PLANT of the OLIN MATHIESON CHEMICAL CORPORATION, Brandenburg, Ky.





Installed out-in-the-open, the unit generates 165,000 pounds of steam per hour at an operating pressure of 650 psig and 750°F. total temperature when firing pulverized coal or gas in a tangent tube, fully water cooled, pressure tight, steel encased setting.

Outdoor installations, with firing equipment housed, have been promoted by Vogt for many years. They help reduce building and operating costs in leading chemical plants and refineries across the nation.

Contact the Vogt representative nearest you before purchasing new steam generating equipment.

For Custom Installation Bulletin VF-VS-2. Package Unit Bulletin PSG-3 address Dept. 24A-BP.

J. F. Pritchard & Co.
Engineers-Constructors

For Direct Long Distance to Louisville dial: 502 ME 4-9411

Vogt STEAM GENERATORS

HENRY VOGT MACHINE CO., P. O. BOX 1918, LOUISVILLE 1, KY.

SALES OFFICES: Camden, N. J., Charleston, W. Va., Chicago, Cleveland, Dallas, Los Angeles, New York, St. Louis

For more facts circle 320 on Reader Service card, p 109

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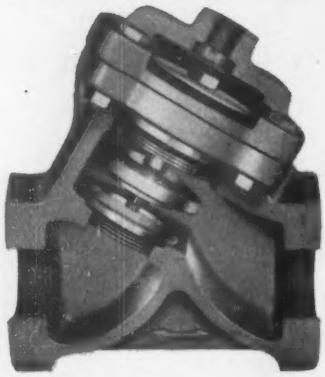

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DIAPHRAGM VALVE?

Check one or more of the following

- ☐ As a power-operated line valve of any kind, normally-open or normally-closed, with better-than-average low pressure-loss and high flow-rate characteristics.
- ☐ As a remotely-operated flow-control valve in an inaccessible location where reliability and long life are important.
- ☐ As automatically-controlled units in a complexity of flow circuits, where rapid and certain response to control signals is significant.
- ☐ As a large power-operated control valve where the actuating power is the actual line pressure, and release is accomplished by simply bleeding this pressure to drain with a small solenoid, pneumatic, or manual valve.

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2. Tear out this Ad and mail to:

AquaMatic INC.

2402 GRANT AVE., ROCKFORD, ILLINOIS

ENGINEERED WATER AquaMatic CONDITIONING CONTROLS

circle 321 on Reader Service card, p 109

Calendar

Sept 14-15 — Engineering Management Conference, American Society of Mechanical Engineers, American Institute of Electrical Engineers, Hotel Roosevelt, New York, N. Y. Details: ASME, 29 W 39th St, New York 18, N. Y.

Sept 21-22 — Industrial Electronics Symposium, sponsored by AIEE, IRE, ISA, Bradford Hotel, Boston, Mass. Details: AIEE, 33 W 39th St, New York 18, N. Y.

Sept 24-27—American Institute of Chemical Engineers, Meeting, Lake Placid Club, Lake Placid, N. Y. Details: AIChE, 25 W 45th St, New York 36, N. Y.

Sept 24-29—Illuminating Engineering Society, National Conference, Chase Park Plaza Hotel, St. Louis, Mo. Details: A D Hinckley, IES, 1860 Broadway, New York 23, N. Y.

Sept 25-27 — National Power Conference, St. Francis Hotel, San Francisco, Calif. Sponsored by ASME and AIEE Power Divisions. Details: ASME, 29 W 39th St, New York 18, N. Y.

Sept 26-28—6th Annual Sanitation Maintenance Show, Sheraton Hotel, Philadelphia, Pa. Details: L S Rogers, 310 Lexington Ave, New York 16, N. Y.

Oct 1-5—Electrochemical Society, Inc, Meeting, Statler Hotel, Detroit, Mich. Details: Electrochemical Society, Inc, 1860 Broadway, New York 23, N. Y.

Oct 2-3—Engineers' Council for Professional Development, 29th Annual Meeting, Sheraton Seelbach Hotel, Louisville, Ky. Details: ECPD, 29 W 39th St, New York 18, N. Y.

Oct 3-6—9th Annual Human Engineering Institute, Stamford, Conn. Details: Dunlap and Associates, Inc, 429 Atlantic St, Stamford, Conn.

Oct 5-7—Solid Fuels Conference, cosponsored by ASME Fuels

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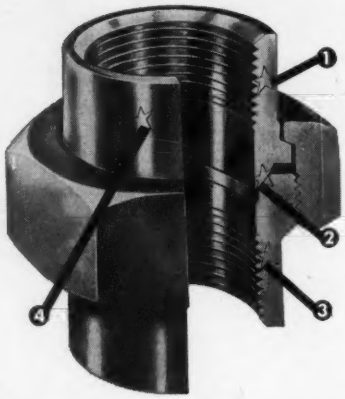
gives you all these features for your forged steel pipe union requirements



1. **Uniform walls** for even expansion and contraction under temperature changes. They follow the pipe!

2. **Catawissa Ball-to-Angle Seats** give you a "Perfect Seal" regardless of pipe alignment!

3. **More than adequate** wall thicknesses give you Catawissa's 3-to-1 Safety Factor (3000-lb. service, 9000-lb. test; 6000-lb. service, 18000-lb. test)!

4. **Round, straight barrels** for fast wrenching. No uneven or tapered surfaces to cause wrench slips or wrench locking!

Catawissa Perfect Seal Pipe Unions are made by Union Specialists from 80,000 lb. tensile strength steel (ASTM Spec. A-105-55T, Grade II). Steel forgings from our own forging mill are closely checked for imperfections . . . and finishing on modern, automatic machines with close inspection during and after production give you pipe unions second to none!

Write for Catalog 60 showing the complete Catawissa line of Perfect Seal Products.

for complete, guaranteed satisfaction

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CATAWISSA VALVE & FITTINGS CO.

CATAWISSA • PENNSYLVANIA

circle 322 on Reader Service card, p 109

PARANITE OIL-PROOF and RAY-MAN CONVEYOR BELT

Over 20 Years' Uninterrupted Service At A Major New England Power Plant

The year: 1940. The requirement: 4,000 feet of conveyor belt to carry oil-treated coal from stockpile to boiler plant at a large electric light and power plant. This meant a "new" oil-proof conveyor belt able to withstand oil emulsion without swelling and causing excessive spillage. The recommendation: Manhattan's Paranite Oil-Proof Conveyor Belt with neoprene cover, one of the first all-synthetic rubber belts made for handling oil-sprayed coal and coke. Result: The Paranite Belt installation did the job . . . and continues to do the job today after twenty years of trouble-free service!

RAY-MAN BELT

Where oil is not a problem, Ray-Man Conveyor Belt will outperform all others. Precision proportioned for perfect balance. Double compensation relieves outer ply stress at bends. Trains naturally, holds fasteners better, resists impact and ripping, requires no breaker ply. Exclusive "XDC" cover for much longer wear. Troughs deeply for 45° idler operation to increase load capacity up to 60%. See your R/M Distributor or write for Conveyor Belt Catalog 25 CB.

CLOSE-UP VIEW OF PART OF 4,000 FOOT PARANITE CONVEYOR BELT. NOTE CONDITION OF BELT AS IT FLEXES OVER PULLEY. TWENTY-YEAR-OLD INSTALLATION IS THE LARGEST OF ITS KIND.

RM 118

RAYBESTOS-MANHATTAN, INC.
MANHATTAN RUBBER DIVISION • PASSAIC, N. J.
ENGINEERED RUBBER PRODUCTS

For more facts circle 323 on Reader Service card, p 109

In the interest of BETTER ELECTRICAL PREVENTIVE MAINTENANCE ...we offer a complete line of improved MEGGER® Insulation Testers

Even the great corps of electrical men who have known and depended on Megger Testers for as long as 50 years will find important and useful new refinements in these most sturdy and reliable of instruments.

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Megohm scale ÷ 1 and ÷ 10, Ohm scale and Capacitance Discharge on one selector switch or the basic megohm scale only.

Ranges from 0-20 to 0-10,000 megohms, at voltages of 400 to 1000 volts d-c. Ohm scales from 0-10,000 to 0-100,000. One model with 500 and 1000 volts d-c in one instrument.

Use them with confidence

These compact, conveniently portable instruments have earned popular acclaim from electrical men everywhere—the men who keep plants operating and production lines moving. These are the men who also keep profits from becoming losses.
A minimum of experience is required to use a Megger Tester and interpret its measurements. The few practical suggestions clearly and simply stated in the well known Megger Manual are all the electrical maintenance man needs to obtain accurate and reliable information for those test records of important production equipment.

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B117

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1316 ARCH STREET • PHILADELPHIA 7, PENNSYLVANIA

Calendar

Begins on page 180

Div, AIME Coal Div, Dinkler Tutwiler Hotel, Birmingham, Ala. Details: ASME Fuels Div, 1300 Leader Bldg, Cleveland 14, Ohio

Oct 8-11—Society of Petroleum Engineers, Fall Meeting, Dallas, Texas. Details: AIME, 29 W 39th St, New York 18, N. Y.

Oct 10-12—Oak Ridge National Laboratory, Nuclear Reactor Chemistry and Analytical Chemistry in Nuclear Reactor Technology Conferences, Gatlinburg, Tenn. Details: Oak Ridge National Lab, P O Box X, Oak Ridge, Tenn.

Oct 17-18—Bulk Solids Symposium, sponsored by Materials Handling Div of ASME, Hotel Nicollet, Minneapolis, Minn. Details: ASME Materials Handling Div, 29 W 39th St, New York 18, N. Y.

Oct 17-19—American Society of Lubrication Engineers, 8th Joint Lubrication Conference, Hotel Morrison, Chicago. Details: ASLE, 5 N Wabash Ave, Chicago 2, Ill.

Oct 19—Diesel Engineers and Users Association, Annual General Meeting, Institute of Marine Engineers, London. Details: Diesel Engineers and Users Assn, 18, London St, London, E C 3, England

Oct 19-20—National Conference on Industrial Hydraulics, sponsored by Ill. Inst of Technology, Armour Research Foundation, Sherman Hotel, Chicago. Details: J Stathas, Ill. Inst of Technology, 35 W 33rd St, Technology Center, Chicago 16, Ill.

Oct 23-25 — International Water Conference of Engineers' Society of Western Pa., Annual Meeting, Penn-Sheraton Hotel. Details: Society Office, Penn-Sheraton Hotel, Pittsburgh 30, Pa.

Oct 23-26 — The Metallurgical Society, Fall Meeting, sponsored by TMS, SME, AIME, Fuels Divot ASME, Pick Fort Shelby Hotel, Detroit, Mich. Details: AIME, 29 W 39th St, New York 18, N. Y.

continued

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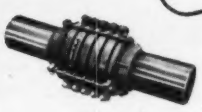
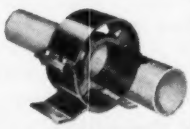
. . . with new Flexonics EXPANSION JOINT *ENGINEERING GUIDE*



EXPANSION JOINTS

EXPANSION COMPENSATORS



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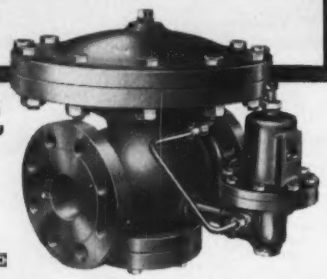
NO CLOGGED ORIFICES
NO STICKY VALVES
NO DIAPHRAGM RUPTURE



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Type
92B
STEAM
REDUCING VALVE

Here's a pilot operated pressure reducing valve designed to minimize problems inherent in steam service. This completely self-contained unit is especially desirable where air or gas is not available as an operating medium.

Once installed, the 92B is easily maintained. Bleed orifice can be cleaned by removing one fitting. Inner valve, seat ring and main spring can all be reached through the blind flange. Precision construction of the pilot gives the valve exceptionally close accuracy. Ask about the new 92B built of high-strength Nodular Iron, for pressures up to 300 psi.

WRITE TODAY FOR BULLETIN D-92B.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD ...CHANCES ARE IT'S CONTROLLED BY...

FISHER GOVERNOR COMPANY
Marshalltown, Iowa / Woodstock, Ontario / Rochester, England
Butterfly Valve Division: Continental Equip. Co., Coraopolis, Pa.

FISHER Controls SINCE 1880

For more facts circle 326 on Reader Service card, p 109

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Men who design and manage energy systems have found it important to know what's happening fast—not last.

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Circulation Manager, POWER, Room 2600, 330 West 42nd St., New York 36, N.Y.

Calendar

Begins on page 182

Oct 23-27 — American Society for Metals, 43rd National Metal Congress and Exposition, Cobo Hall, Detroit, Mich. Details: A R Putnam, ASM, Metals Park, Novelty, Ohio.

Oct 29-Nov 1—National Lubricating Grease Institute, 29th Annual Meeting, Rice Hotel, Houston, Texas. Details: NLGI, 4638 J C Nichols Pkwy, Kansas City 12, Mo.

Nov 6-9—American Nuclear Society, Atomic Industrial Forum, Annual Winter Meetings, and Exhibits, Conrad Hilton Hotel, Chicago, Ill. Details: ANS, 86 E Randolph St, Chicago 1, Ill.

Nov 26-Dec 1—American Society of Mechanical Engineers, Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

Dec 3-6—American Institute of Chemical Engineers, Meetings. Hotel New Yorker, New York. Details: AIChE, 25 W 45th St, New York 36, N. Y.

Dec 6-8—American Institute of Mining, Metallurgical and Petroleum Engineers, Inc, 19th Electric Furnace Conference, Penn-Sheraton Hotel, Pittsburgh, Pa. Details: AIME, 29 W 39th St, New York 18, N. Y.

1962

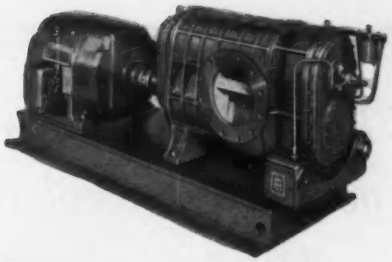
Jan 29-Feb 2—Electrical Engineering Exposition, sponsored by AIEE, New York Coliseum. Details: Reber-Friel Co, 117 S 17th St, Philadelphia 3, Pa.

Feb 4-7—American Institute of Chemical Engineers, Meeting, Statler Hotel, Los Angeles, Calif. Details: AIChE, 25 W 45th St, New York 36, N. Y.

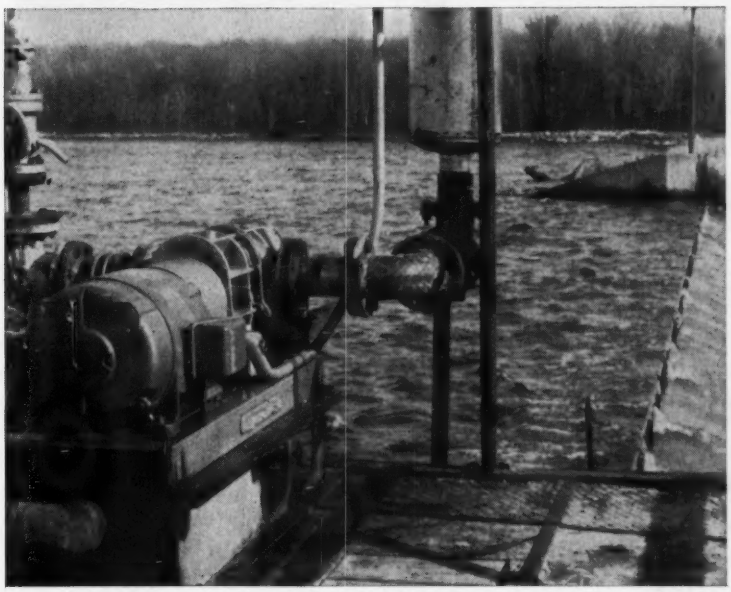
Feb 12-15—12th Exposition of the Air-Conditioning and Refrigeration Industry, sponsored by ARI, Los Angeles Great Western Exhibit Center: Details: ARI, 1346 Conn. Ave, NW, Washington 6, D. C.

Axi-compressor

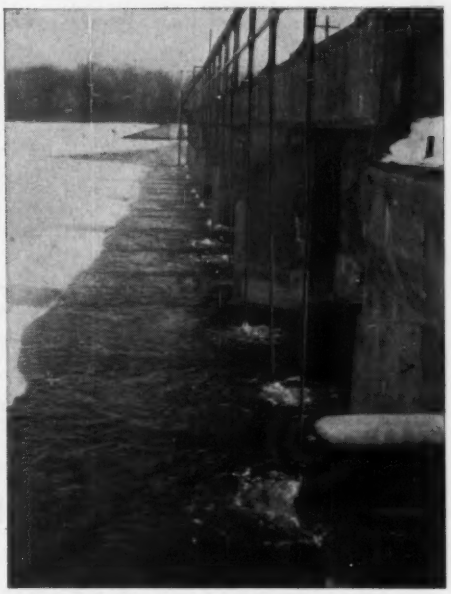
makes effective



DAM DE-ICER



Ingersoll-Rand Axi-compressor installed on power dam of The Mead Corporation to prevent icing by air-agitation of the water.



Upstream side of dam, showing air lines from header extending down into agitated ice-free water.

The long, cold winters of Michigan's Upper Peninsula are hard on dams. Heavy and prolonged icing causes rapid erosion of even the strongest reinforced concrete. After making extensive repairs to its power dam at Boney Falls, The Mead Corporation, a leading paper manufacturer, installed a simple yet highly effective air-agitation system to protect against future ice damage.

The anti-icing system uses low-pressure air to agitate the water along the upstream side of the dam and bring the warmer sub-surface water up to the top. For this purpose, an Ingersoll-Rand positive displacement Axi-compressor was installed midway across the dam, delivering 295 cfm at 10 psig to a 4" header line extending the length of the structure. Every few feet along the header, hoses extend downward into the water to 7 feet below mean level. Each hose terminates in a metal pipe with a 5/64-inch orifice which emits air for bubbling. As shown in the photo at right above, the uprising air and water keep the river ice a safe distance back from the dam.

The Axi-compressor is an ideal unit for this type of service. Being small and free from vibration, it can be installed on a simple, low-cost foundation. And maintenance costs are low because the two meshing helical rotors do not touch each other or the casing and hence have no mechanical wear.

Ingersoll-Rand Type L Axi-compressors are available in capacities from 100 to 12,000 cfm, for pressures to 15 psig and vacuums to 22" Hg. Ask your Ingersoll-Rand engineer for complete information, or send for a copy of Bulletin No. 11,003.

Ingersoll-Rand

191A17 11 Broadway, New York 4, N.Y.

THE WORLD'S MOST COMPREHENSIVE COMPRESSOR EXPERIENCE

For more facts circle 328 on Reader Service card, p 109

What makes the first gear-type coupling still first choice?

Check design . . . and you'll find Fast's Couplings (the original gear-type couplings) are superbly engineered, ruggedly built, smoothly running units designed to outlast the machines they connect.

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NOW 15 to 450 GPM!

VIKING'S ENLARGED LINE OF HEAVY DUTY HELICAL GEAR DRIVEN PUMPS

Figs. 288 and 388 units with size "C" reducers, capable of handling up to 25 H.P. at 350 pump R.P.M.; 40 H.P. at 520 pump R.P.M. 20 to 450 G.P.M. capacities. Five gear ratios available, using one gear case. Six pump sizes in this series.

You now have an even larger range of Viking's helical gear driven units to fit your pumping jobs. Speed and capacity now range from 15 to 450 G.P.M. They're ideal for handling both thin and thick liquids, ranging from gasoline to molasses. Pumps equipped with packing or mechanical seals. Gear reducers independently mounted. All components can be quickly changed. Step up your delivery with these quiet, positive discharge, self-priming pumps!

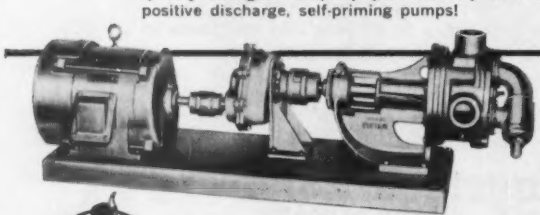

Fig. 288 units with size "B" reducers, capable of handling up to 10 H.P. at 1750 R.P.M. motor speed. 15 to 225 G.P.M. capacities. Six sets of gearing using one gear case. Six pump sizes in this series.

50 YEARS

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VIKING PUMP COMPANY

Cedar Falls, Iowa, U.S.A. In Canada, It's "Roto-King" Pumps

See Our Catalog in Sweet's Industrial Construction and Plant Engineers File

For more facts circle 333 on Reader Service card, p 109

Appointments

Institute elections

Warren H Chase

American Institute of Electrical Engineers' new president is Warren Chase. Vice-president of the Ohio Bell Telephone Company, he has served as an AIEE vice-president since 1958. He replaces Clarence H Linder.

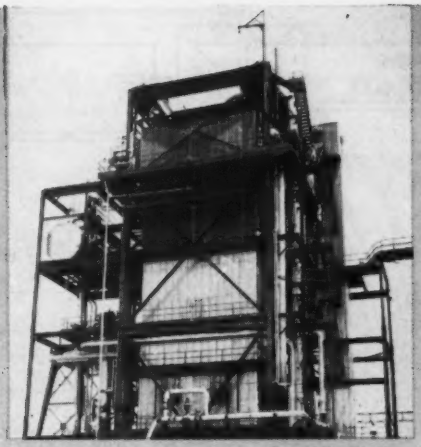
Everett Elliott

National Oil Fuel Institute—the new body formed as a result of the Oil Heat Institute of America and the National Fuel Oil Council merger—has elected Everett Elliott as its first board chairman. President of C L Elliott Company, he was chairman of the Distribution Div of the Oil Heat Institute and past president of the Oil Heat Institute of New England.

Internal Combustion Engine Institute: C E Nelson Jr, Waukesha Motors Co, president; P Norton, Wisconsin Motor Corp, vice-president. **American Power Dispatchers Association:** J L Price, system dispatcher for Southern California Edison Co, president; J T Morcom, Salt River Power District dispatcher, vice-president. **American Society for Engineering Education:** Dr R W Van Houten, president, Newark College of Engineering, president; Dr G A Marston, Dean of Engineering at University of Mass., Dr C L Wilson, Dean of Missouri School of Mines and Metallurgy, vice-presidents.

continued

since 1948...
continuous expansion
at
Central Louisiana Electric
piped by Midwest



Coughlin Station

In 1948, Midwest fabricated and erected the piping for Central Louisiana Electric Company's Coughlin Station, Units 1 and 2. Total capacity for both units was 7,500 KW, operation conditions 625 pounds @ 825°.

Midwest continued to furnish piping for the station's four subsequent expansions, including a 100,000 KW unit in 1961, and for the first two units of the company's Teche station. Combined capacity of all units piped by Midwest was 270,000 KW.

Midwest's proven capabilities for quality fabrication and erection have resulted in "repeat business" like this from many major power companies.

The story of Midwest's coordinated fabrication-erection service is told in a 24-page illustrated brochure, POWER AND PROCESS PIPING. Write for your free copy today.

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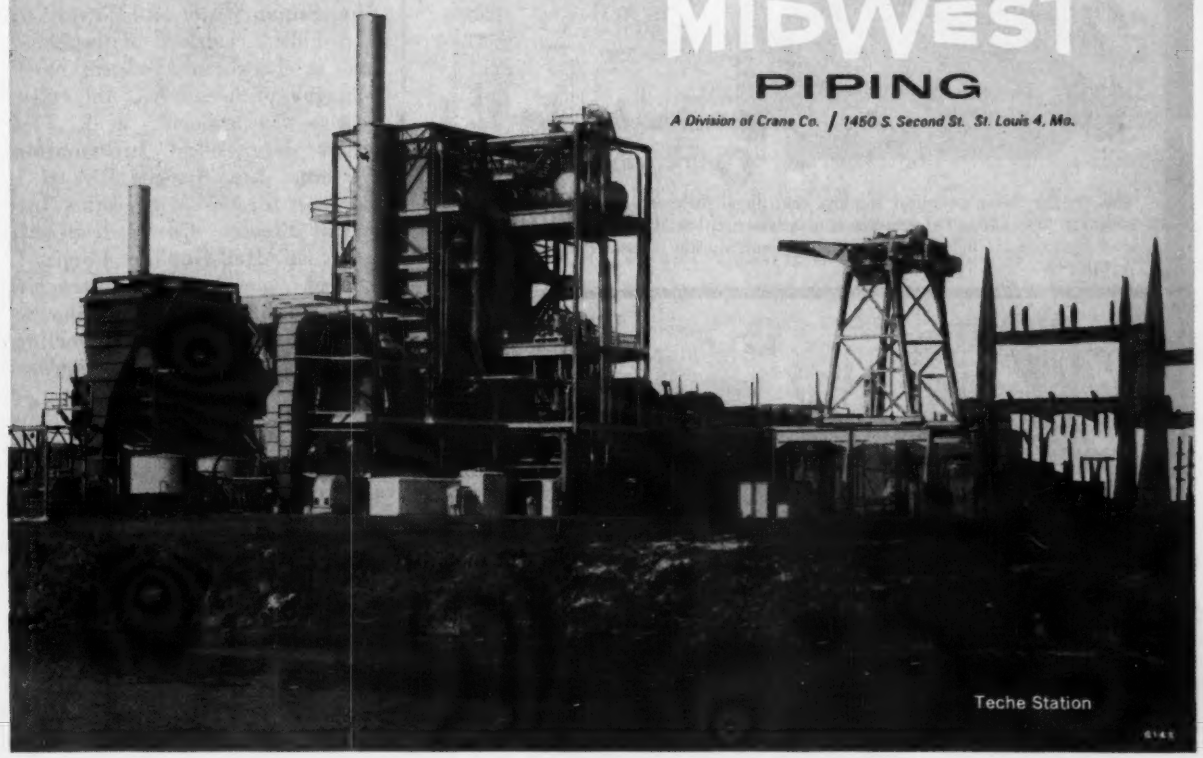
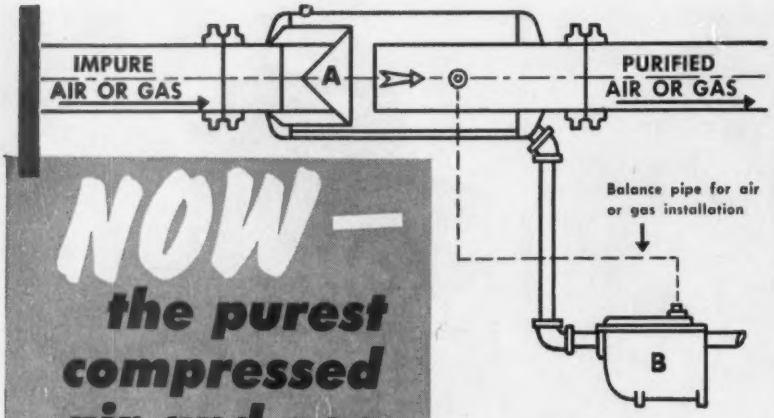
PIPING
A Division of Crane Co. / 1450 S. Second St. St. Louis 4, Mo.



Teche Station

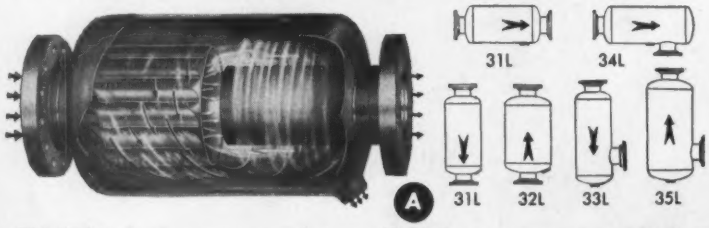


NOW— the purest compressed air and gas is yours with this W-A equipment

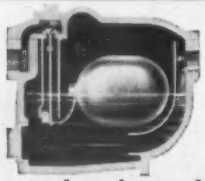
GUARANTEED TO REMOVE 99% OR MORE OF ENTRAINED MOISTURE AND SOLIDS

Where pipe lines carry compressed air and gas, liquids and solids are generally entrained in the gas stream. Wright-Austin 30L Series Separators can be used to remove foreign matter on a wide range of applications. For operating pressures to 5000PSIG. Line sizes to 24". Here are some typical applications:

REMOVE
- —oil and water from compressed air supply lines
- —oil and water on compressed air service at outlet of inter-cooler and after-cooler equipment.
- —oil, moisture and tar between stages in coke oven gas compressors
- —oil and water from CO_2 gas lines
- —oil and water from hydro-carbon lines
- —entrainment from vapor lines following evaporation



This Wright-Austin separator employs centrifugal force to remove impurities from steam, air or gas flow. The pressure drop is extremely low. Type 31N, as well as other models shown, is light weight, compact and sturdily constructed according to ASME code.



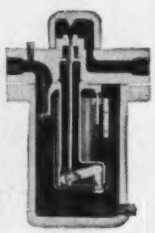
23-AC TRAP (0-125 PSIG)

Separated condensate flows to trap. Drainage is automatic. Particularly adapted where cold, gummy, emulsified cylinder lubricants make ordinary traps inoperative.

B

101-AC TRAP (0-600 PSIG)

Cast steel body, cover and bonnet. Designed for draining condensate where high pressures are involved. Internal mechanism all attached to cover for easy service.



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Export Dept., 8 South Michigan Ave., Chicago 3, Ill.

Appointments

Begins on page 186

Illuminating Engineering Society: J R Chambers, sales manager of Appleton Electric Co, president; J D Mitchell, regional engineer of Westinghouse Electric Corp, vice-president. **American Society of Lubrication Engineers:** D M Cleaveland, Bendix Corp, president; L B Sargent Jr, Aluminum Co of America, vice-president-at-large.

General managers

Allis - Chalmers Manufacturing Co: K R Geist. **Electric Machinery Mfg Co,** E-M Control Div: R J Mullenbach. **Fluor Corp, Ltd,** Power Div: J H Hemsarth. **Cohu Electronics, Inc,** Kin Tel Div: R E McDowall. **Hamilton-Thomas Corp,** Klipfel Valve and Economy Pump Div: D M Rosencrans. **Fred H Schaub Engineering Co:** E S Nelson. **Moloney Electric Co,** Switchgear Div: D E Spackler. **Air Reduction Sales Co,** Cryogenic Engineering Dept: W B Moen. **Fairbanks, Morse & Co,** Hydraulic Products Group: A H Heim.

Management changes

Shawinigan Water and Power Co: J A Fuller, chairman of the board and chief executive officer; W F Mainguy, president; A C Abbott, executive vice-president; W R Way, senior vice-president. **Information Systems, Inc,** Systems Div: H L Bechard, director of engineering. **Imperial Electric Co:** R J Hearty, president. **Heil-Quaker Corp:** L Conrad, president. **LeTourneau-Westinghouse Co:** L J Burger, president. **Frink Corp, Sterling Bronze Co:** G H Meyner, president.

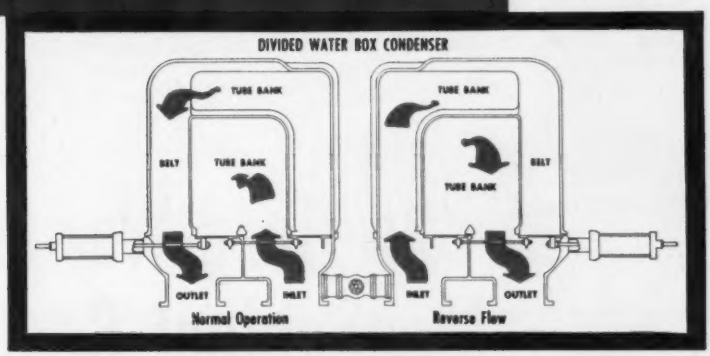
Purchases and mergers

Cooper-Bessemer Corp acquired Kline Manufacturing Co. **Boice Gages, Inc** purchased Reli-A-Chek Corp. **Fairbanks, Morse & Co** purchased Herold Radio and Electronics Corp. **Curtiss-Wright Corp** acquired assets of Abrams Instrument Corp; purchased interest in Target Rock Corp. **Hoffman Industries, Inc** acquired Air Appliance and Filtration Divisions of U. S. Hoffman

REVERSE FLOW "SELF-CLEANING"

ELIMINATES CONDENSER DOWN TIME

AND CUTS YOUR MAINTENANCE COSTS



C. H. Wheeler "Patented" Reverse Flow Condensers eliminate *manual labor* for cleaning. Refuse, twigs, leaves, debris, algae, or mussels are freed and washed away by back-flushing tubes and tube sheets, without shutting down the condenser.

Reversing can be accomplished during full load operation and full flow of circulating water, without additional pressure drop; hence high vacuum is maintained. Sluice gates for each half of the condenser move on a common stem. They are an integral part of the condenser and no extra external piping is required.

Each half of the condenser can be back-flushed independently or both halves can be flushed simultaneously, with either one or two circulating pumps operating.

For complete Reverse Flow "Self-Cleaning" story— write for catalog W-503. To know how Reverse Flow "Self-Cleaning" can cut YOUR condenser down time costs—call your C. H. Wheeler representative.

WGR

Affiliated sources for steam condensers, heat exchangers, pumps, nuclear steam generators and related components, sea water distillation plants, marine auxiliary equipment.

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Now proved in over

1,000

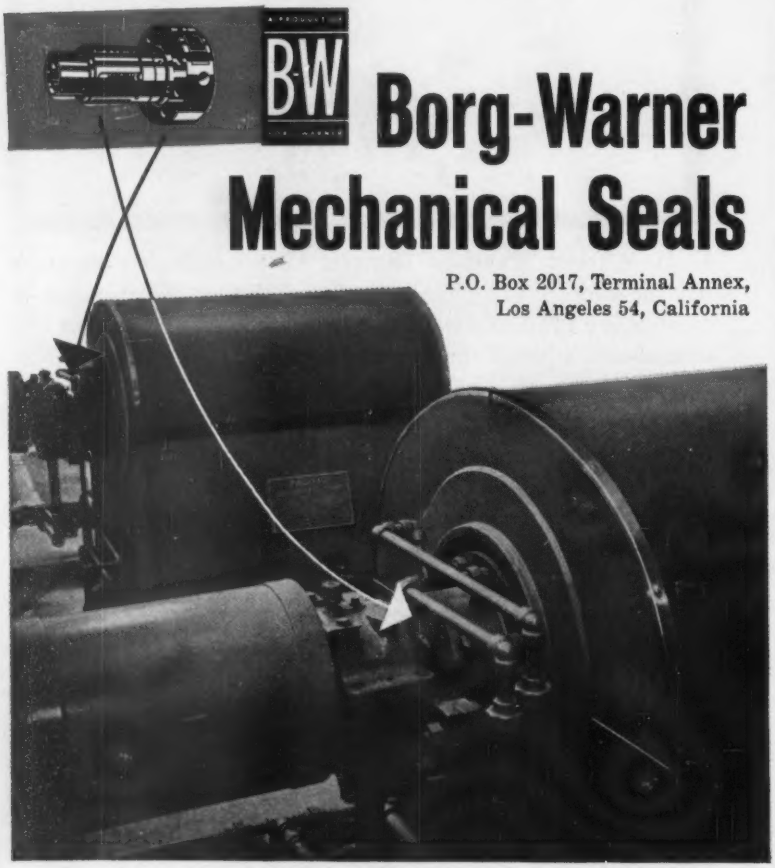
Installations

More than a thousand Borg-Warner Type "D" Mechanical Seals are installed for high pressure, high temperature applications, and are proving their worth with phenomenal performance records —many operating well over three years in continuous boiler feed pump service!

Especially designed for long, reliable duty under these conditions, the Type "D" Seal offers other important savings by eliminating or greatly reducing leakage of heat and treated feed water, and cutting expensive maintenance down-time. Further, no cold condensate injection is required for cooling.

Call or write for the new Borg-Warner Type "D" Seal Bulletin with complete engineering and installation information—there's no obligation!

Partial List of Type "D" Seal Users: *California Electric Power Co. • Toledo Edison Co. • Gulf States Utilities • Louisiana Power & Light Co. • Shell Oil Company • Union Electric Co. • Texas Company • Consolidated Edison, New York • Florida Power & Light • Owensboro Public Utilities • Union Oil Co., Wilmington • Tennessee Valley Authority • Baltimore Gas & Electric Co. • City of Los Angeles Dept. Water and Power • Detroit Edison Co. • Southern California Edison Co. •Hawaiian Electric Co. • Philadelphia Electric • Mississippi Power & Light • Houston Light and Power Co. • City of Burbank • City of Pasadena • Iowa Power & Light*



Borg-Warner Mechanical Seals

P.O. Box 2017, Terminal Annex, Los Angeles 54, California

Appointments

Begins on page 186

Machinery Corp. **Pioneer Belting & Conveyor Equipment Corp** has taken over assets of Corns Conveyor Belt Co. **Diamond Power Specialty Corp** purchased Diamond Blower Co Ltd, Ferry-Diamond Engineering Co, Ltd and Fyrex Ltd.

Meridian Systems, Inc acquired Francis Economy Boilers, Inc. **Air Reduction Co, Inc** agreed to acquire Speer Carbon Co. **Foxboro Co** plans to acquire Waugh Engineering Co. **Texas Gas Transmission Corp** now has controlling interest in Kentucky Electronics Inc. **Tuthill Pump Co** purchased Ossian Engineering Co, Inc. **Pall Corp** merged with **Trinity Equipment Corp. Connecticut Light and Power Co** merged with **Housatonic Public Service Co,** which will be a division.

Vice-presidents

Sangamo Electric Co: Rear Admiral R Bennett, senior vice-president and director of engineering. **Bailey Meter Co:** H H Gorrie, executive vice-president. **Jeffrey Manufacturing Co:** F J Durzo, executive vice-president. **H K Porter Co, Inc,** National Electric Div: S C Powers, vice-president and general manager.

Engineer changes

The Okonite Co: R C Waldron, chief engineer. **Thompson Ramo Wooldridge Inc,** Tapco Div: R J Shafranek, chief engineer of electrical-power-equipment section; F H Guth, control-equipment-section chief engineer. **Precision Transformer Corp:** G F Simmons, chief engineer. **Allis - Chalmers Manufacturing Co:** E S Boyko, K F Neusen, H W Yant, assistant engineers in nuclear-power dept. **Fred H Schaub Engrg Co:** C R Johnson, chief engineer.

Retirements

B J Wilson, mechanical-engineering technical advisor for Leeds & Northrup Co, after 33 years. **J G Swain,** vice-president of Waukesha Motor Co, after serving the company for 36 years. **L E Osborne,** consultant to Westinghouse Electric Corp board chairman, after 51 years.

Please don't feed the "TUBE EATERS"

Don't let unnecessary pitting, cracking or erosion chew up tubes before their time. Don't let *any* type of corrosion, scale or biofouling hamper your heat exchange efficiency without checking these four factors:

• Is the tube alloy *right?* Will a vital difference in corrosion resistance result from a minor alloy change—or is an entirely different alloy called for? • How much will performance be improved by Duplex bi-metallic tubes which provide the best metal or alloy for *each* heat transfer medium. • Will a change to thickened-end or thickened-center tubes give needed extra resistance where attack is most severe? • What actual data on similar exchanger operations are available?

We at Bridgeport can help you. Our condenser tube experience dates back to 1900 but our files are completely up-to-date on tube problems reflecting the high pressures, temperatures and velocities of modern operations. Write Bridgeport Brass Company, Bridgeport 2, Connecticut.

Bridgeport condenser and heat exchanger tubes in over 50 metals and alloys:

INHIBITED ADMIRALTY
INHIBITED ALUMINUM BRASS
INHIBITED MUNTZ METAL
70-30 CUPRO NICKEL
90-10 CUPRO NICKEL
DEOXIDIZED ARSENICAL COPPER
INHIBITED ALUMINUM BRONZE
RED BRASS
ALLOY 77 MERCURY BRASS

...plus **DUPLEX TUBES**...in combinations of the above alloys, with carbon or stainless steel, aluminum, Monel,® nickel...or other metals.

BRIDGEPORT BRASS COMPANY

Bridgeport

For more facts circle 335 on Reader Service card, p 109

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OPERATIONAL ELECTRICITY

Theory, Characteristics, Applications, and Mode of Operation of Circuits and Machines

By CHARLES I. HUBERT, *U.S. Merchant Marine Academy, Kings Point, N. Y.* A major break from tradition, this book integrates the study of A-C and D-C machines. It recognizes that the fundamentals apply equally to both systems — that D-C is a special case of A-C at a frequency of zero cycles per second. Wherever possible the author injects applicable operating techniques, in addition to clear descriptions of motors and controls, magnetic controllers, and regulators. 1961. 530 pages. $8.50

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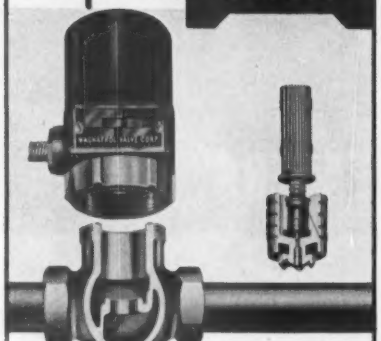
Magnatrol SOLENOID VALVES



. . . ARE RUGGEDLY & ACCURATELY CONSTRUCTED TO GUARD AGAINST COSTLY FLOW FAILURES.

The entire operating mechanism of Magnatrol Solenoid Valves can be **cleaned, repaired or replaced** WITHOUT removing the valve body from the pipe line or breaking flexible electrical leads.

This unusual design advantage plus the fact that every Magnatrol Valve is CUSTOM ASSEMBLED and FACTORY TESTED . . . means greater dependability.

Available in normally closed and normally open models, in pipe sizes from 1/4" to 3". Pressure ranges from zero up to 500 psi.

Catalog mailed upon request.

Magnatrol VALVE CORP.
Hawthorne 10, New Jersey

circle 337 on Reader Service card, p 109

Bookshelf

Theory of Hydrodynamic Lubrication. *By Oscar Pinkus, Technical Research Group Inc, and Beno Sternlicht, General Electric Co. 500 pp, 242 illust, $15.00. McGraw-Hill Book Co, 330 W 42nd St, New York 36, N.Y.*

This comprehensive treatment of hydrodynamic and hydrostatic lubrication emphasizes the basics of a wide range of design problems and applications. Applying the general principles of fluid flow to bearing operation, the differential equations of lubrication (including energy and elasticity) are formulated. Also covered: incompressible lubrication, gas bearings, squeeze films, variable viscosity, non-Newtonial fluids and extensions of classical theory.

Each chapter is followed by a list of sources. This will be especially useful to readers who would like detailed background of a specific area.

Elementary Fluid Mechanics, 4th Edition. *By John K Vennard, Professor of Fluid Mechanics, Stanford University. 570 pp, illust, $7.95. John Wiley & Sons Inc, 449 Park Ave S, New York 16, N.Y.*

This edition recognizes the increased importance of basic science in engineering education. Most significant additions: greater stress on flow-field concepts, a deeper treatment of compressible flow and a new chapter on some elementary concepts of mathematical hydrodynamics.

Scope is limited to the portion of fluid mechanics that fits reasonably in an introductory course, and greater emphasis is placed on physical concepts than on mathematical manipulation. Text is studded with illustrative problems, plus over 100 problems at the ends of chapters. Source references guide the student to more extensive treatments of the various topics.

Ultrasonics. *By Benson Carlin. 307 pp, 9½ x 6½, $11.50. McGraw-Hill Book Company, Inc, 330 W 42nd St, New York 36, N.Y.*

Slanted toward practical engineering design and industrial applications,

measurement and control

of pressure and differential pressure

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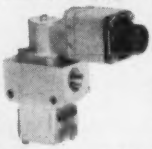

Adjustable for signalling pressure and differential pressure from 0.25" wc to 200 psi (or psid) in systems to 5000 psi and −65° to +275°F; leakproof. Units sound alarm, light bulb, turn motor on or off, operate valves — remotely or in place. $40 to $75

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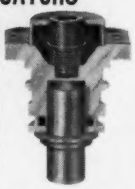

Adjustable and non-adjustable. Actuation 0.01 to 100 psi (or psid). For same pressure/temperature as switches. Red button pops to give visual indication of overpressure. $22 to $85

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TRANSMITTERS Complete with remote or in-place recorder.

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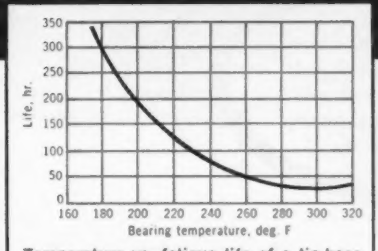
circle 338 on Reader Service card, p 109

OMNIGUARD...

THE "SUPERVISOR" THAT SHOWS YOU EASY PLACES TO CUT PLANT OPERATING COSTS

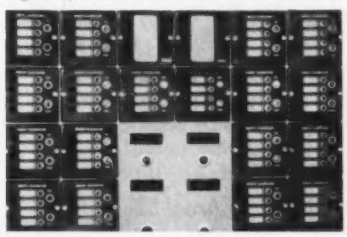
There are three basic ways to combat the steadily rising cost of plant operation. Two of them are hard ways: buying higher capacity initial equipment, or, trying to find more efficient equipment. So many advances have already been made in these directions that any overall economy you may gain in the future promises to be small.

But the third way to save—and this is the easy one—is to increase the *reliability* of your equipment, thereby lowering your maintenance expenses and perhaps even reducing the amount of standby equipment needed. *Omniguard* is a proven *supervisory system* that enables you to do just this. It continuously supervises bearing temperatures in your heavy rotating equipment, preventing bearing failures and *extending* bearing life, sometimes by years. Omniguard also monitors lube oil pressures, pump suction and discharge pressures, and other variables of a critical nature. Monitors and indicators installed at any convenient location away from the equipment, display the readings and provide warning signals and automatic shut-down of equipment if desired.



Temperature vs. fatigue life of a tin-base babbitt bearing at a unit load of 2000 psi.

Dozens of machines at as many different locations can be watched from a single panel for signs of excessive bearing operating temperatures.



Omniguard keeps constant watch on the important temperatures and pressures in your plant—makes it easy for you to avoid the expensive repair jobs and down time that would otherwise be part of your operating expense.

For complete information on the Edison Omniguard System, and the variations available for different kinds of machinery, write for Catalog 3036D.

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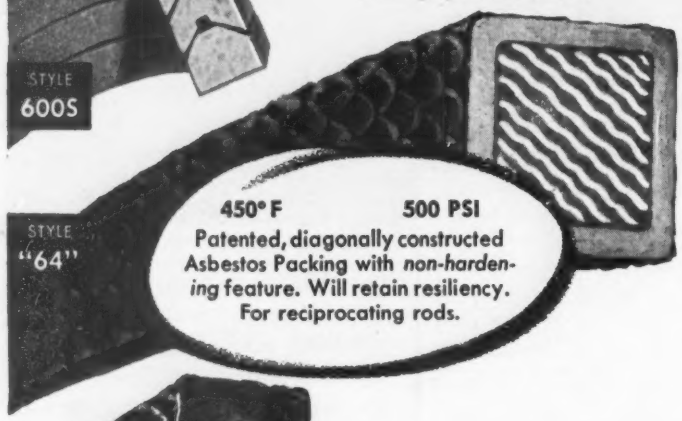

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Bookshelf

Begins on page 192

this book covers theory and methods of generating waves, outlines circuits and electronic considerations, gives data on mechanical and electrical-system design. The revised and updated second edition includes new developments in testing materials, cleaning, welding, medical and other applications. It discusses advances in the design of generators and transducers, ways of testing ultrasonic equipment.

Covered in plain language are such topics as beam-transducer size, ways of producing ultrasonic waves, different types of electromechanical converting systems.

Gas and Air Compression Machinery. *By Lyman F Scheel, Consulting Engineer, 338 pp, illust, tables, cloth, $12.00. McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 36, N.Y.*

This is a convenient guide to the use of modern pneumatic machinery. It covers all compressor types—reciprocating, centrifugal, axial flow—plus blowers and fans. Special sections deal with valves, lubrication and drives. At the close of each major section, a reference bibliography guides readers to detailed source material. Problems let the reader test depth of understanding gained from each section.

Text is specifically aimed at application, project, process and sales engineers together with plant design and operating staffs. A rational expression for reciprocating-compression efficiency makes it possible to derive realistic power needs from intrinsic enthalpy. One section is a mathematical treatment of the static and kinematic behavior of gases.

TVA plans 1962 construction start for a $125-million steam plant on the Clinch River between Knoxville and Oak Ridge, Tenn. Operation is scheduled for 1965. Initial 900,000-kw steam turbine-generator is on order from General Electric Co.

Public Service Electric and Gas Co. Turns Fly Ash Problems Into Profit

By using Fuller pneumatic conveying systems, the Sewaren Generating Station of Public Service Electric and Gas Company, New Jersey, was able to collect 4100 tons of fly ash during 1957. Not only did this eliminate a serious disposal problem that formerly contributed heavily to operating costs . . . it also gave the utility which sold the collected fly ash, a new and valuable source of income.

The Fuller-Kinyon system at Sewaren collects and carries the fly ash to two storage silos that have a combined capacity of 380 tons. It is then either bagged in 50-lb. lots or transferred in bulk through a Fuller loading-out silo spout to tank trucks or covered dump trucks. Labor and equipment costs are kept at a minimum. Dusting is avoided, and high tonnages are handled easily over considerable distances. Extra handling flexibility is provided by a Fuller two-way diverting valve that permits unsuitable fly ash to be pumped directly to an ash reject tank instead of to storage.

Fuller pneumatic conveying systems can be installed almost anywhere at minimum costs, regardless of plant conditions. Moisture and dirt cannot enter the system and material cannot escape. Write today for detailed information in Bulletin FF-49-1. 1334 G-202

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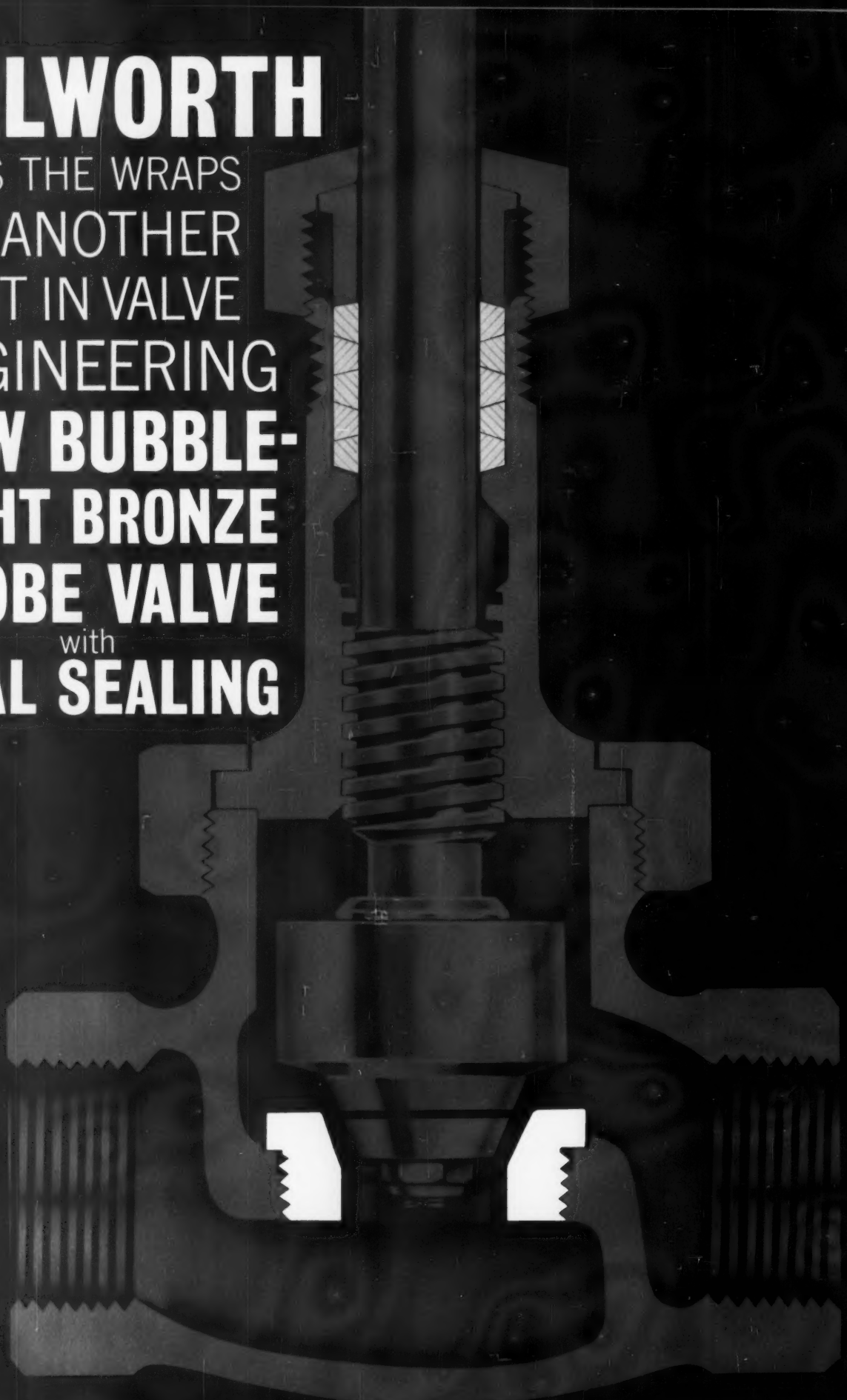
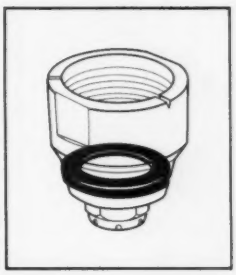
NEW BUBBLE-TIGHT BRONZE GLOBE VALVE

with

DUAL SEALING



ABSOLUTELY BUBBLE-TIGHT!



Here's the newest concept in valve design. Resilient unplasticized resin insert gives absolute shut-off in critical piping—at low torque. Now available for your particular requirements, the new Walworth Bubble-Tight Bronze Globe Valve is already in service aboard nuclear submarines, and in cryogenic gas piping systems—and is particularly suitable for the most critical water, oil and gas piping systems.

DUAL SEALING This unique unplasticized resin insert provides full 360° seal against matching monel seat. Secondary metal-to-metal seating further assures tightness... consistently. Write for descriptive bulletin.

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— and how long will the flexing member last?

Good question. The heart of Para-flex is a tire with synthetic tension members bonded together in rubber—which provides a flexing body that automatically compensates for *all combinations* of misalignment and end float, and absorbs vibration as well!

This amazing coupling has now been used in American industry 4 years. Thousands are in operation—in steel mills, paper mills, oil fields, mines, quarries, chemical plants, everywhere—and in these 4 years, replacements of elements have been negligible.

Dodge Standard Para-flex takes angular misalignment up to 4°, parallel misalignment up to 1/8" and end float up to 5/16" depending upon the size of the coupling and the duration of shaft displacement.

Dodge Para-flex is available in 3 types—Standard, Flywheel and High Speed (shown at right). The Standard type is stocked in capacities up to 3640 hp at 910 rpm. Ask your Dodge Distributor, or write us for complete technical bulletin.

Dodge Manufacturing Corporation, 3200 Union Street, Mishawaka, Indiana

The Products with the Pluses . . .

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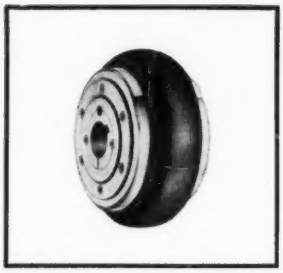
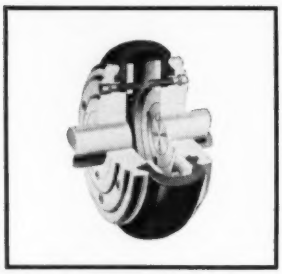
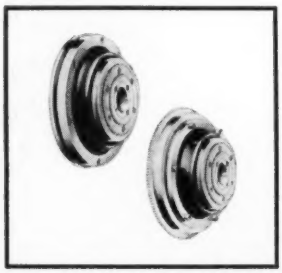


The new idea in flexible cushion couplings, with a flexing member that "swallows up" misalignment.



No lubrication, no maintenance. Replace flexing element without moving driver or driven machine.



Flywheel and High Speed Types. For use with motors and internal combustion engines turning up to 5230 rpm.

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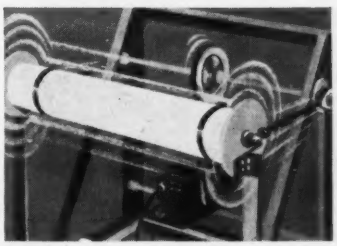
TOUGH

NEW PIPE INSULATION

...deflection at breaking point 2 to 4 times that of ordinary insulation



You can almost forget about handling breakage with remarkable new "K&M" Zebra. As proved in tests by K&M and independent testing laboratories, Zebra won't crack or warp from shock or heat. It withstands intense vibration without cracking or abrading.

Zebra is made in half sections even for the larger pipe sizes... for faster application with fewer joints. Despite its rugged, full body, it's relatively lightweight... easy to cut and fabricate. It's a low, medium and high-temperature multi-layer sectional-type thermal insulation. And it meets your requirements for density, conductivity, modulus of rupture, and resistance to soaking heat. Write today for more information and a free sample of new "K&M" Zebra. It's tough, economical, fast to apply. That's Zebra... by K&M! Keasbey & Mattison Company, Ambler, Pa. Dept. I-191.

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• for temperatures of 200°F to 1200°F • smooth surface won't irritate or cut skin • made of calcium silicate-asbestos fiber bonded felts • can be re-used . . . dismantled and re-applied • practically dust-free • available in a wide range of sizes and thicknesses.

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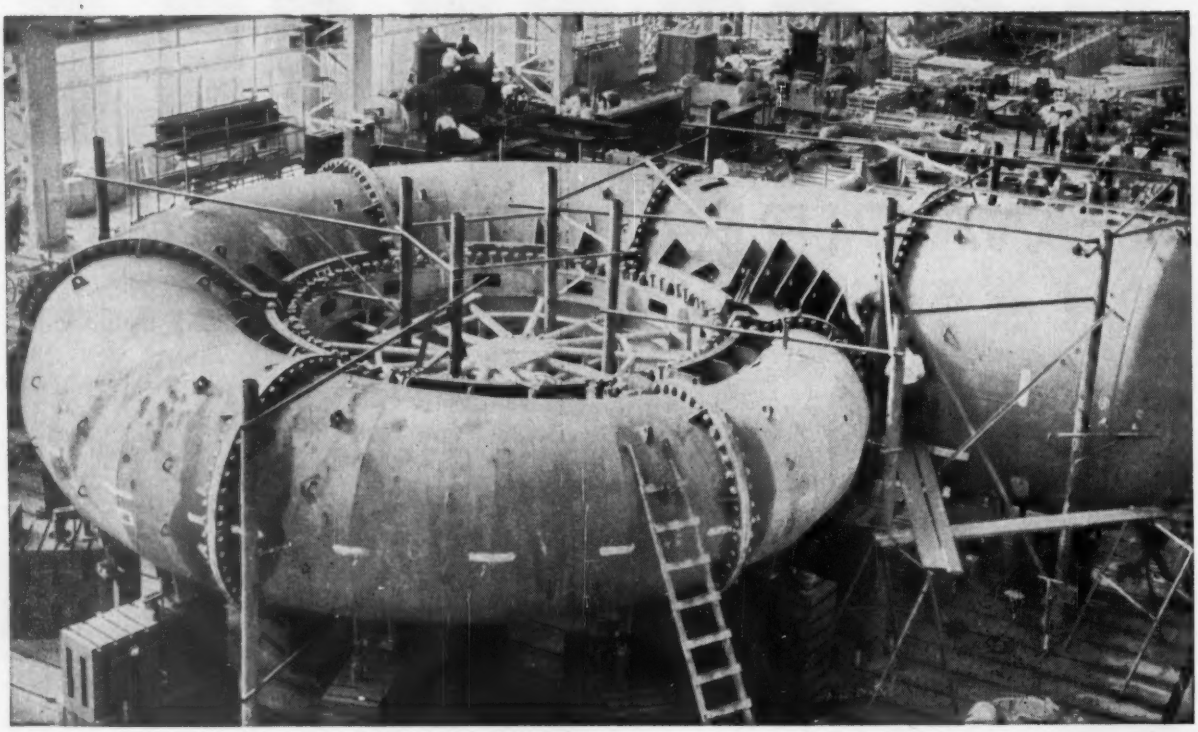
Keasbey & Mattison at Ambler

HITACHI

now completing the first hydraulic turbines for Thailand's Yanhee Project



Shop tests were recently completed on the spiral casing for the first of two 115,000 HP Francis-type turbines being completed by Hitachi for Thailand's Royal Irrigation Department. These will be the first of the planned 8 sets of generating units to be installed at the downstream of the Bhumiphol Dam, as part of the Yanhee Multipurpose Project which will commence operation in 1963 and eventually supply 560,000 kW of power to Bangkok and Thonburi. The vertical shaft Francis turbines have been designed to deliver 115,000 HP under the effective head of 112m and for a speed of 150 rpm. Their spiral casings, with inlet diameter of 4150mm, will each be divided into 7 sections for transportation by barge up the Ping River to the site.

Hitachi, Ltd.
Tokyo · Japan
Cable Address: "HITACHY" TOKYO

ONE OF A SERIES OF CHATS ABOUT CONSERVATION AND CONTROL OF HEAT

SARCO TOPICS

SO YOU THINK YOU'VE GOT TEMPERATURE CONTROL PROBLEMS

When plant men get together and talk about their temperature control problems, strong men may weep. It's so darned basic—that narrow range of degrees which must be maintained—so closely allied to profit and loss. Let us tell you about one situation that may even top yours, and may clue you in on a good solution. It concerns wine, of all things.

Take those basic temperatures. Wine must be pasteurized at 140°F. Those are the facts of life in the world of wine. They might not seem too difficult to live with unless you are concerned with heat. Then you probably know how tough things can get when you have a rendezvous with a thermometer.

Take New York's Monarch Wine Company, producers of Manischewitz Wines. Their Problem: how to maintain the 140° temperature in the heat exchangers despite wide variations in the rate of wine flow. These variations, between 5 to 60 gallons per minute, result from slowdowns and recoveries in the bottling process. Problem: entire system must be capable of complete shutdown when necessary. Problem: wine temperatures must be raised to 140° as rapidly as possible, sometimes an immediate jump of 100°.

Attracted perhaps by aspects of the situation that had little to do with pure science, Sarco engineers applied the collective experience of Sarco technology to the solution of this serious problem. The result for Monarch: the *degree of control* the process demanded—achieved through the excellent use of Sarco Temperature-Pressure Regulators, Float Thermostatic Steam Traps Thermo-Dynamic Steam Traps, and Pipeline Strainers.

Sarco engineers, ever resourceful, divided each of the two large Cherry-Burrell plate-type heat exchanger units into two separate

sections with a blank baffle plate, each with a separate Sarco control. Thermal sensing bulbs were installed in wine discharge and throttling controls hooked into steam supply. As demand fluctuates, one or both regulators function to maintain the 140° temperature. In higher demand, both regulators are operative; as demand drops and flow decreases, only one regulator supplies steam. Pasteur himself would have been elated.

Each of six smaller capacity shell-and-tube heat exchangers required only one regulator, with the sensing bulb inserted into the outlet side of the wine filled shell, and the regulator throttling steam supply to the tube section. Thus, by controlling flow of steam to the exchangers on the basis of pressure and temperature, the Sarco regulators were able to maintain the temperature of the wine at precisely 140° regardless of fluctuations in demand or supply rate. Whew! A lot of engineering went into those two sentences.

From here on it's downhill. To secure complete cut off of the steam supply during scheduled shut-downs of the bottling run, solenoid valves were provided to supplement normal modulating action of the controls. To discharge widely varying loads of condensate continuously and remove immediately all air and incondensible gases, Sarco Float Thermostatic Steam Traps were installed on all condensate outlets. On the drips before each control valve a Sarco Thermo-Dynamic Steam Trap was installed to insure delivery of dry steam. Sarco Pipeline Strainers were installed before all steam traps and valves to protect them against damage by any foreign bodies. And thus ends a classic story of the grape.

Still, this story has been condensed far too much, really, and we feel you've been cheated out of the story's more delicious details. You needn't be, however. We've printed the facts in detail for posterity and you in Sarco Case History 185, complete with drawings that practically make it a do-it-yourself kit. If you would like a copy, we will be flattered to receive your request, and dispatch it with dispatch.

WE'RE ALWAYS IN... AND THE WELCOME MAT'S OUT

We always take it for granted that if you are going to be in the vicinity of our plant you'll phone or drop us a line so we can invite you to visit us. You'll find that our factory in Bethlehem, Pennsylvania, is on many well-travelled routes, and that our steam laboratory has much to offer in interest and helpfulness. Forgive us for being immodest, but the lab is the most up-to-date of its kind in the country.

When you visit us, don't allow yourself to get sidetracked by the drill presses and automatic lathes. We're proud of this equipment but you've probably seen metal mutilated before, and it's our steam laboratory that's unique. We promise you a good show, and if you have any problems, bring them along. We'll solve them while you wait.

ANYONE FOR KEY CHAINS?

Need a key chain? A tiny replica of a Sarco Thermo-Dynamic Steam Trap, Type TD-50 is attached but you can always remove it if you find it too commercial. There are many things you could use these chains for. Fishing sinkers? Lengthening a light cord? Even holding keys? Anyway, if your Sarco representative is out, write in.

Pardon our monopolizing the conversation in this series of paid communiques, but we're trying our best to interest you in certain subjects that concern us both—to the point where you'll communicate.

6355

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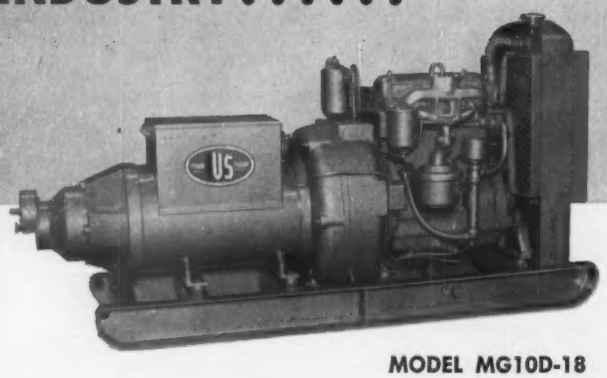

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10 KW DIESEL MICRO POWER FEATURES —

- no brushes, commutator, or slip rings to service or replace with new brushless generator
- squirrel cage motor with less than one percent slip
- conservatively rated bearings
- diodes arranged for easy access
- voltage adjusting potentiometer
- magnetic amplifier regulator mounted directly on unit
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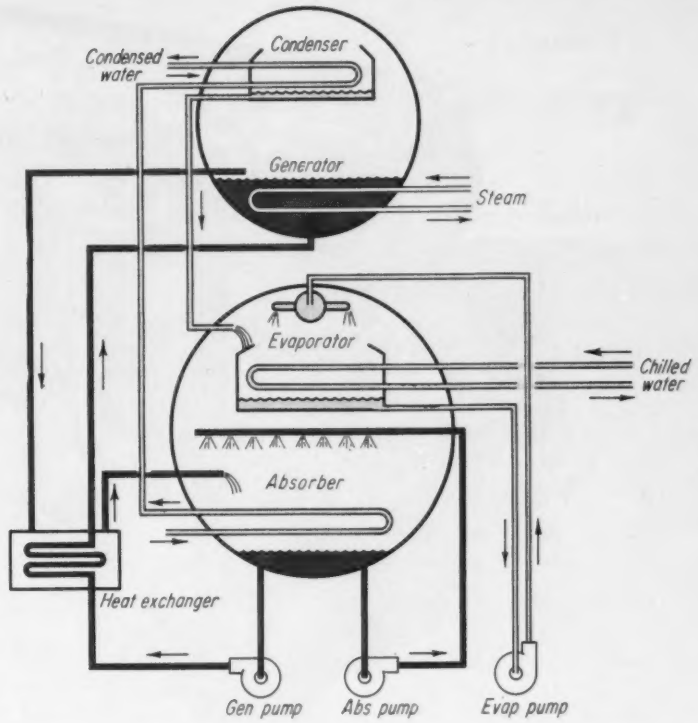
Plant maintenance and management section

STEVE ELONKA
Associate Editor in Charge



Avoid headaches next season by combining shutdown procedure with these . . .

Six steps in overhauling your absorption system

By WILLIAM J WREN
Carrier Air Conditioning Co

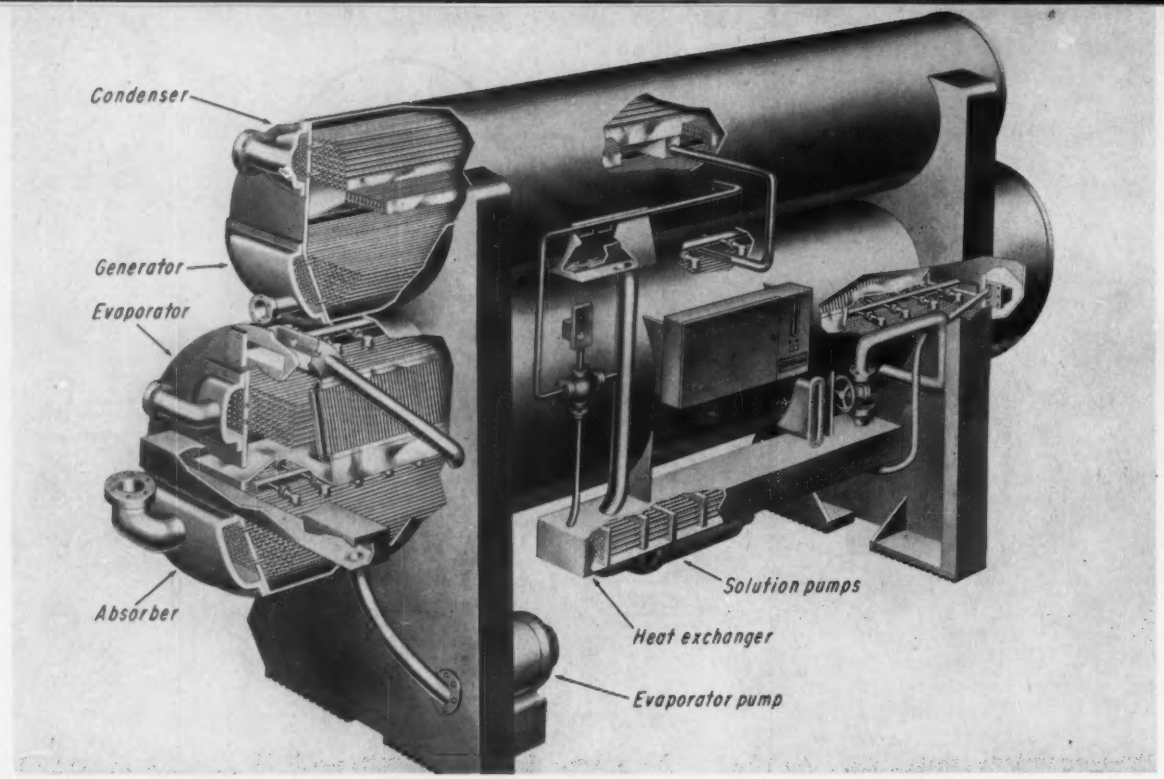
EDITOR'S NOTE: *This is the first of a 4-part series on shutdown maintenance of air-conditioning and refrigeration systems, all authored by W J Wren. Other parts will cover centrifugal and reciprocating systems, cooling towers and air-handling systems.*

For trouble-free operation next year, your air-conditioning equipment needs careful maintenance *now*. We'll start by outlining the points to remember when shutting down an absorption system; other articles in this series will cover centrifugal and reciprocating systems, cooling towers and air-handling systems. The four parts aim to completely cover conventional types.

Heat-operated absorption system is the oldest of all mechanical refrigeration devices in principle, yet the newest in application. Basic absorption machine divides into nine major components: condenser, generator, evaporator, absorber, heat exchanger, purge system, solution pumps, evaporator pump and controls. Of course, there are numerous minor components.

This system, beginning with low-pressure steam or high-temperature water, chills water by evaporation. Cycle is based on two principles: a lithium-bromide solution will absorb water vapor, and water will boil, or flash-cool itself, at low temperatures when subjected to a high vacuum. In the absorption machine, water is sprayed in a shell kept under high vacuum. A portion of the water flashes, and this cools the rest. Then the lithium-bromide solution absorbs the water vapor.

Since the solution is diluted by absorbing vapor, it must continually be strengthened. This is done by pumping the weak solution to a generator



ABSORPTION-REFRIGERATION unit with solution capacity control is compact, needs less attention than most other types

where steam, hot water or other hot solutions boil off the excess water. The strong solution is then returned to the absorber where it takes on more water vapor.

Since the absorption machine has no major moving parts, it is relatively vibration free and needs less maintenance than any other type of central refrigerating apparatus. But it still does need care, and you must take the same pains you would for any machine. As experience has proved, careful maintenance is especially important in the first few years of the machine's life.

Inspection given an absorption machine after a full operating season should be thorough—done only by a qualified maintenance staff. Owners who don't have skilled people available should consult their equipment manufacturer about a service and maintenance contract. But assuming your staff includes competent servicemen, here is a logical inspection routine for them to follow:

Absorber and condenser. Inspect tubes for algae, mud and scale. If tubes are dirty, clean them with brushes, Fig. 1, or water pressure, Fig. 2. Hard scale can only be removed chemically, and if you do find it, it's a good idea to consult a local water-treating company. Using proper treatment methods will not only control scale deposits in tubes but also prevent growth of organisms in cooling towers and on coil surfaces.

Controls. Operating and safety controls should be checked with the machine running. If it isn't possible to operate the machine normally during the inspection period, you can simulate operating conditions by shutting the manual valve in the steam-supply line. Then pull the condenser water-pump-fuse disconnect switch and cooling-tower-fan disconnect switch. Manually block the chilled-water or differential-flow switches in closed position. When you've done these things, the evaporator pump, solution pump and purge system will operate normally when the start button is pressed.

Check operation and calibration of safety controls—the low-temperature-cutout switch, Fig. 3, purge-level safety control, chilled and condenser-water safety switches.

Operating controls to be inspected include the capacity-control valve and motor, purge-not-purge switch, stop-go switch and time-delay switch. Be sure to note time of dilution cycle.

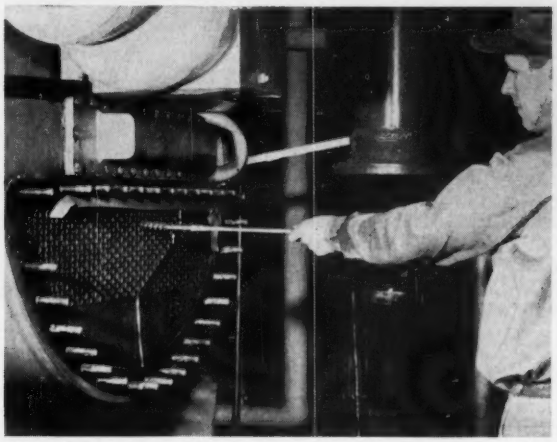
Leak test is the most important part of the inspection. Even a small air leak is going to pull down operating efficiency and, if not repaired, may damage internal components. After you shut down the machine for the winter, perform a standing vacuum test. If any leakage is indicated, equalize the seal chambers to prevent damage to the seals. Then introduce 5 to 10 lb by weight of Refrigerant-12 and pressurize with nitrogen to 25 psig, Fig. 4. Test the entire machine with a halide or electronic leak detector. A soap-solution test will pinpoint leaks.

Don't overlook your tube bundles. Remove drain plugs, first making sure the line valves are closed, and probe the waterbox and condensing-water circuit.

Purge. Drain the solution from the purge tank, Fig. 5, and thoroughly flush and clean the tank. Purge cooling coil, pump, jet evacuator and piping with water, Fig. 6. Clean purge-level probes.

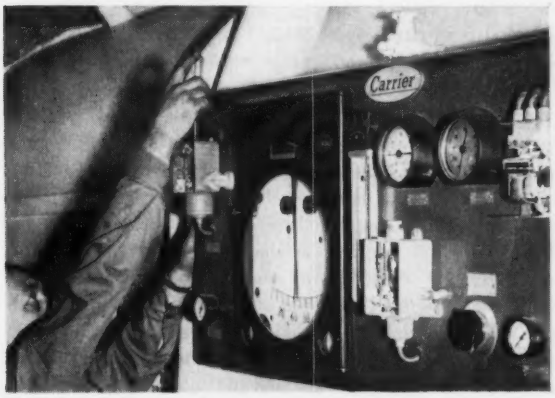
Purge's high-level safety switch may be checked by raising solution level in the tank until the switch trips. After the high-level switch trips, lower the solution level to let the switch close. Don't forget, all solutions removed from the machine for testing must be put back into the system after testing is complete.

Just six operations, performed each time you shut down, keep this reliable machine turning out refrigeration for the next cooling season

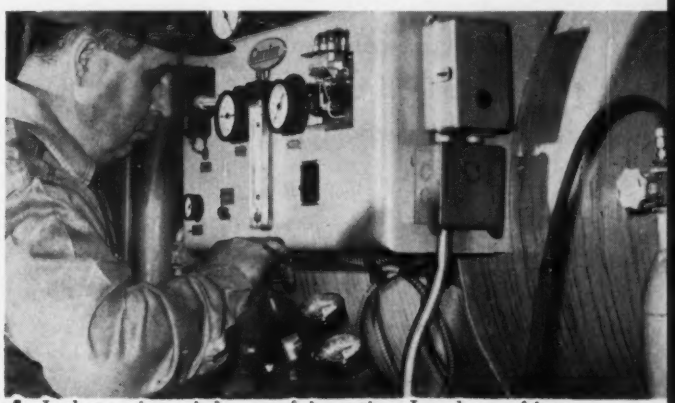


1 If hard-to-remove algae, mud and scale build up on absorber and condenser tubes, a brush may be best bet to scrub them

2 Water washing is often enough to clean absorber and condenser tubes. Chemical removing may be answer to hard scale

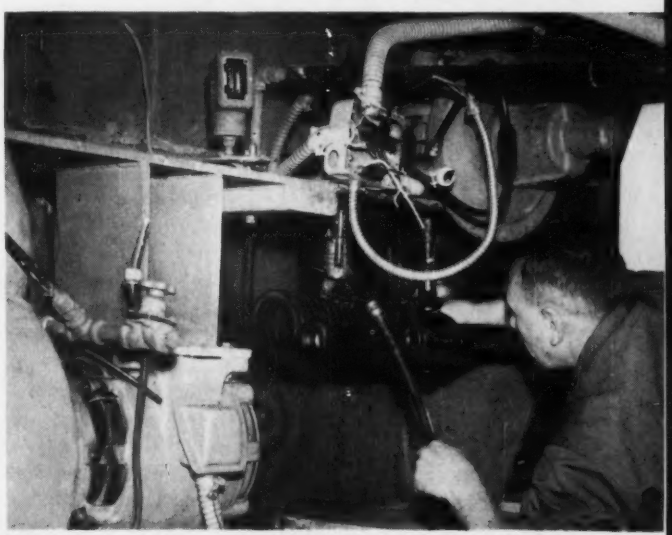


3 Check low-temperature-cutout switch for operation and calibration; test purge-level control and other safety switches



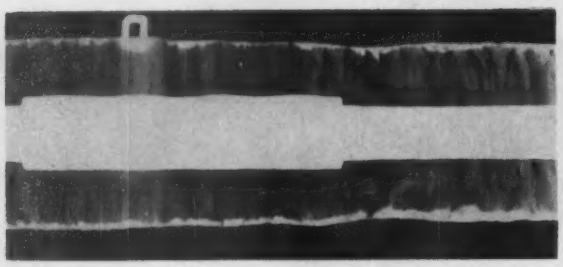
4 Leak test is a vital part of inspection. Introduce refrigerant and pressurize with nitrogen to 25 psig to find the leaks

5 Drain solution from the purge tank, then thoroughly flush and clean the tank. This care pays off in efficient operation

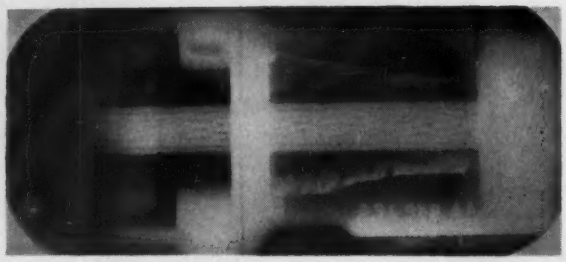


6 Use water to purge the cooling coil, pump, jet evacuator and piping. Then clean the purge-level probes for good measure

A little experience and you'll easily spot potential sources of failure



GOOD CABLE SPLICE looks like this. Note indents slightly visible on upper edge of splicing sleeve. Insulation thickness is uniform through length. Up-and-down streaks are solder on shield



BASE OF 15-KV POTHEAD shows void (dark area) extending all the way from top of porcelain down to pouring plug in brass base. Picture was taken through ½ in. of solid brass. Cable is at center

You can locate voids and defective workmanship in nonlead cable splices and terminations nondestructively. Use these techniques to . . .

Test potheads and cables by X-ray

By T L BOURBONNAIS II
E I du Pont de Nemours & Co, Inc

Incipient defects in material or installation can come to a head in violent, emergency failure, forcing unscheduled shutdowns which result in high production losses and extra costs. Such incipient weakness is hard to detect. High-voltage tests find some defects, but others stay hidden—you never know they're there until they cause electrical failure.

A void may occur inside the high-voltage termination (nicknamed the pothead) as a result of potting-compound shrinkage, for example. High-voltage testing may not show it up. But if the void is next to the cable and water subsequently gets into it, failure can occur shortly after you've run a successful high-pot test.

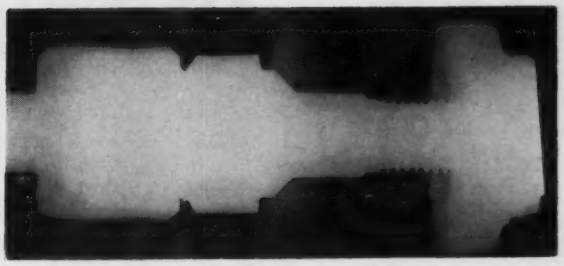
Du Pont's Engineering Dept has found that X-ray analysis of terminations, a nondestructive method, can detect many assembly and installation defects of this type. We've also used the same analysis to a lesser degree to inspect cable splices for possible internal defects.

To date, we have taken about 250 radiographs, and they show that there are defects in 95% of all terminations. We think many of these are unimportant; however, knowing about them has let us improve our techniques, resulting in better terminations all around. It is interesting to note that our terminations are made by many different people: our own company cable splicers, cable splicers of the various utilities that serve our plants and transient construction mechanics supplied by local contractors throughout the country. Because we have so many plants—approximately 80 located from coast to coast—we feel that this is a representative sample of today's termination and cable-splicing techniques. Very likely the same construction mechanics who were employed to make our terminations and splices will also be making yours.

Many of the defects are serious. Cable-termination and -splice failures destroy the equipment so thoroughly that they leave little evidence of the real cause. Although high-voltage-dc cable tests sometimes indicate voids in potheads, particularly if they are filled with water, this type of testing has proved very limited in finding defects in potheads immediately after installation. But the X-rays we've taken have uncovered many previously undetected faults. These trace to a number of causes: improper materials have been used, potheads have been assembled incorrectly, mechanical connections have not been properly tightened, stress cones are absent on the shielded cable in potheads, shielding tape on stress cones has been improperly applied. Many voids were present in places where they could ultimately cause failure.

While most of our X-ray inspections showed defects, on one job we expected trouble and didn't find it. An aerial 3-conductor 500-MCM cable showed ruptured armor after six months of operation. This cable's armor was covered with polyethylene. At the point where the aluminum armor fastened to the covering over the splice, it had separated, and several turns of the armor had pulled apart for a total distance of about five in. on both sides of the splice for some reason not readily apparent.

VOID IS EVIDENT as black area in this 33-kv pothead. Original cable insulation can be clearly seen in the center of the porcelain. But a void such as this is not necessarily detrimental



COMMON POTHEAD DEFECT results when connector is not properly seated in porcelain cap. Note distance between connector shoulder and porcelain—because the key wasn't positioned right

This looked terrible, but X-ray analysis of these 3-phase splices showed that the conductors had not pulled out or moved within the compression splicing sleeves inside the splices. Insulation around the splice was not seriously deformed. As a result of the pictures, we decided the splice was satisfactory. We wrapped weatherproof tape over the armor that had pulled apart, and the installation is still in operation after two years.

Psychological effect of the presence of X-ray equipment on a job has a lot to do with our improved terminations. We have taken considerable trouble to show the pictures to the mechanics who do the work. One particular hard-to-convince cable splicer said, after inspecting some pictures, "If I hadn't seen it, I wouldn't have believed it." He was referring to voids in the compound that he had just poured into a pothead. (The next pothead he poured was excellent—proof of X-rays' educational value.)

All the radiographs above were taken with equipment manufactured by the Balteau Electric Corporation. We use the Balteau Spot 140 in the field. This equipment is marketed by the Westinghouse Electric Corporation. We have also tried an iridium-isotope camera with excellent success, but a little more skill is needed because the intensity of radiation continually changes, which requires different exposures from day to day.

We develop all the radiographs of field installations in the medical darkroom of the plant, using the same technique of developing as is normal for medical X-rays. This simplifies the problem of laboratory work—we just give the X-ray film holders to the regular medical-darkroom technician for processing and refilling.

It's true, of course, that better pictures can be obtained by using special lab techniques tailored to this particular type of industrial X-raying. However, from the standpoint of economy most developing can be handled by the medical technicians with perfectly adequate results.

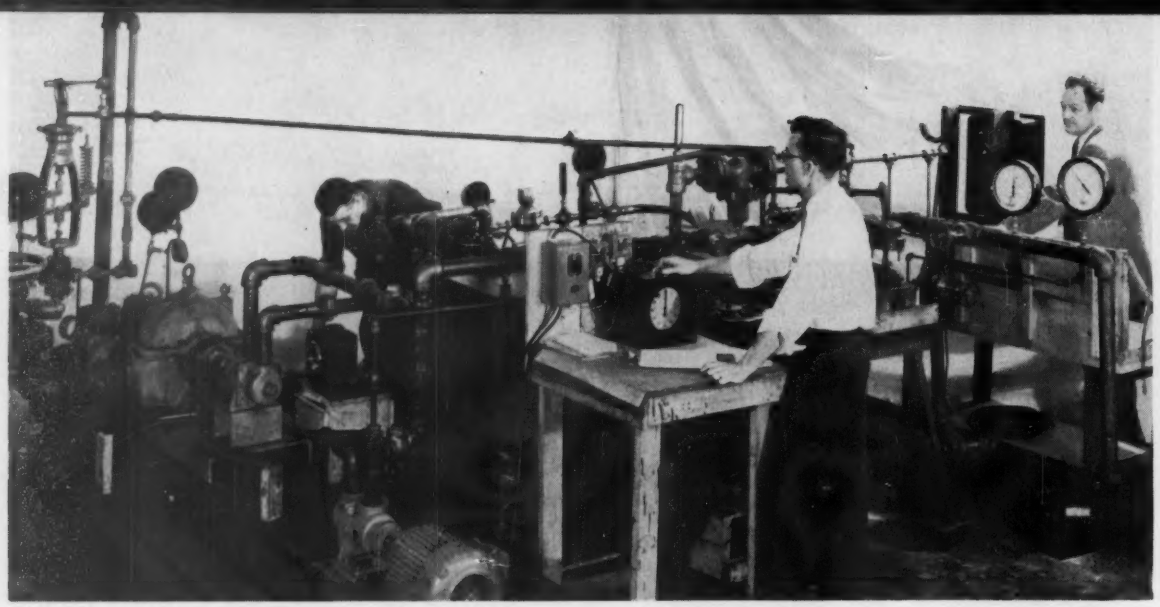
Is it difficult to take radiographs? Take a look at the actual working instructions used in one case: (1) Find a dark closet. In it, open a package of 4½x10-in. Du Pont No. 506 X-ray film. Insert one sheet of film between two 0.005-in. lead screens, metal side toward the film. Put these in a film holder and attach to back of porcelain skirts on pothead. (2) Set up X-ray unit so that X-ray tube is exactly 16 in. from the film. (3) Set timer for 1-minute exposure. (4) Follow operating instructions accompanying X-ray unit and adjust for a penetration of eight (80% of 140 kv). (5) After exposure is complete, take film holder to darkroom and have medical technician develop it by normal processing methods.

Safety is an important consideration. We use a radiation meter to indicate the limits of danger while making exposures, to protect the health of people in the vicinity of the work. The radiographer, at any rate, should wear a film badge or Dosimeter to check total radiation he has absorbed. We like the Dosimeter because it can be read easily at any time during the working period to check total absorbed radiation. A special power supply is required to set this instrument.

In general, safety problems are easily solved. A masonry wall is usually an effective shield, but you should check to be sure. Our machine provides a 50-ft cable between the pothead and control box. This is a good, safe distance from the radiation source during operation, although our radiation meter indicates this long a distance is not normally required.

Radiation hazard is serious, but it can be entirely controlled by a few simple precautions, and so you won't need a professional industrial radiographer. A technician can be trained in a few hours to do the work. Our experience has convinced us that the X-ray is a valuable inspection technique, letting us catch and correct incipient defects before they add up to costly failures.

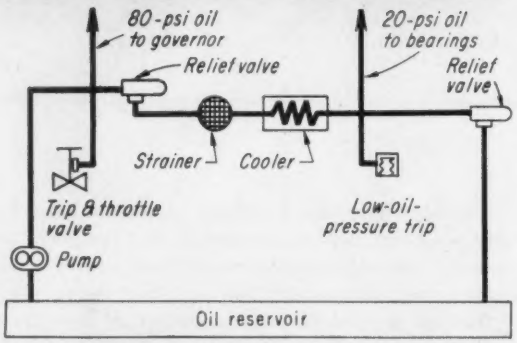
EDITOR'S NOTE: *This subject is treated at greater length in the author's AIEE paper 61-242, "Nondestructive testing of cable terminations and splices by X-ray analysis," available from AIEE, 33 W 39th St, N. Y. 18.*



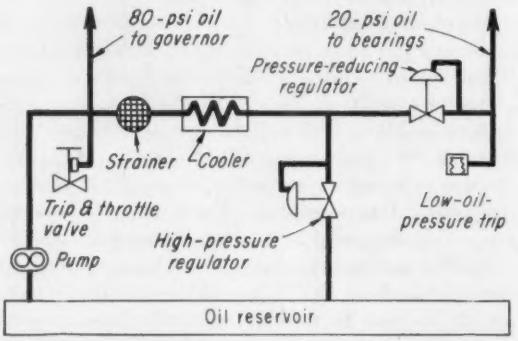
THIS TEST SETUP was used to verify operation of the new oil system on sudden loss of main oil pump and on sudden governor demand with varying oil requirements. Setup simulated an actual installation, and pipe sizes and length of runs were kept the same

Tests point to a better turbine lube-oil system

By R S KEPHART, Research Engineer
Worthington Corp, Steam Turbine Div



CONVENTIONAL OIL SYSTEM has governor-oil pressure maintained by relief valve discharging into the lube-oil line



IMPROVED SYSTEM has governor-oil pressure maintained by a high-pressure regulator discharging into oil reservoir

Most modern steam-turbine oil systems have a main oil pump driven from the turbine shaft. An auxiliary pump, if needed, is driven by an electric motor or a separate small steam turbine. But if the turbine's speed varies over a wide range, or where process demands continued operation even should the main oil pump fail, turbine builders provide an independent oil system. These systems usually have a motor-driven oil pump and a separate turbine-driven oil pump—one is the main pump and the other an auxiliary.

Independent oil systems must be reliable. If the main oil pump fails, the auxiliary must start up quickly to prevent dips in oil pressure, because enough of a dip will trip any turbine shutdown device, whether it's a trip and throttle valve or low-oil-pressure trip mechanism. The system must, as well, avoid tripping these shutdown devices when a sudden load change on the turbine brings about a hurry-up demand for more oil for control.

Two different designs for independent oil systems used with turbine machinery are shown in sketches, above. System in top sketch is a conventional design, with governor's oil pressure maintained by a high-pressure relief valve which discharges into the lube-oil line. Lube-oil pressure is maintained by a low-

This equipment was used in lube-oil-system test setup

Two identical oil pumps discharging through check valves into the governor-oil line. One pump was driven by a NEMA Class-B electric motor and the other by a single-stage steam turbine

One pressure regulator set to maintain 80 psig in the governor oil line by relieving excess oil back to the reservoir

One pressure-reducing regulator which received oil from the governor-oil line and reduced the pressure to 20 psig for lubrication

Three calibrated globe valves in return lines to the reservoir. These valves were used to simulate governor leakage flow, governor sudden-demand flow and lube-oil flow. The governor sudden-demand line also contained a solenoid valve

One 10-gal hydropneumatic accumulator in the governor oil line

One 20-ft-long valve distance loop in the governor oil line and a 6-ft-long valved distance loop in the line to the accumulator These loops were provided for checking the effect on system pressures of longer pipe runs between high-pressure regulator and governor-relay valve, and between accumulator and governor-relay valve

One trip and throttle valve set to trip when the governor oil pressure dropped to 25 psig. One low-oil-pressure trip mechanism set to trip at 9-psig lube-oil pressure. These are standard trip settings for the system oil pressure involved

Control equipment for automatically starting either oil pump when governor oil pressure dropped to 70 psig

Instrumentation for determining oil pressures and temperatures in the system, and for measuring elapsed time between cut-in of the auxiliary oil pump and re-establishment of full governor-oil pressure

An auxiliary heating system used to keep lube oil at 120 F

pressure relief valve which discharges oil to the reservoir.

Oil cooler and filter are conventionally located after the high-pressure relief valve as shown. They are subject, when clean, to an oil pressure only slightly higher than that of the lube oil. But here is one fault of this system: on sudden failure of the main oil pump, the high-pressure relief valve acts to maintain governor oil pressure by closing rapidly. In so doing, it starves the lube-oil system. Then the low-oil-pressure trip shuts down the main turbine. This fault has been overcome by using lube-oil-line accumulators, or by using a restricted bypass around the high-pressure relief valve.

System in bottom sketch is, we believe, an improved arrangement. Here the governor's oil pressure is maintained by a high-pressure regulator which discharges oil to the reservoir. Lube oil is supplied through a pressure-reducing regulator. Thus, if the main oil pump suddenly fails, the high-pressure regulator closes, but it doesn't starve the lube-oil line. Instead, this system maintains the correct line oil pressure.

Oil coolers and filters of 100- to 125-psi design-pressure ratings are located in h-p line of this system.

Experiments verify successful operation of this second system. We conducted tests to check its operation on sudden loss of main oil pump and on sudden governor demand with various lube-oil and governor-oil requirements. Test setup simulated the oil system of an actual installation. Table above shows equipment used in this test setup.

Pipe sizes and length of pipe runs between critical points were those used in normal practice. Photo shows the arrangement we used.

What did these tests show? They proved that this system works well in case of sudden loss of main pump, and when governor suddenly demands oil. The NEMA Class-B motor used to drive the one oil pump attained speed quickly when cut in. It stopped equally fast when the circuit was broken to simulate failure of the main oil pump. Turbine-driven oil pump took relatively longer to reach full speed, even though this turbine was designed for excess power capacity to improve its starting torque. This pump also tended to drift slowly to a stop when taken out of service.

A combination of the turbine-driven main oil pump and motor-driven auxiliary pump worked well in all tests without an accumulator. We had to use an accumulator in the governor-oil line with the motor-driven main-pump arrangement. This offset the slower-starting turbine-driven auxiliary pump and did not trip the turbine-shutdown devices when the main oil pump failed.

Minimum governor-oil pressure was not influenced by adding the 6-ft-long accumulator distance loop. Additional tests showed no adverse effect on system minimum pressure when a 26-ft accumulator distance loop was used. In the runs testing sudden governor demand, however, there was a slight reduction in minimum governor-oil pressure when the oil line to the governor was lengthened.

While the first system is widely accepted in the turbine-machinery field, our tests indicate advantages of the second system. Test results coupled with successful field experience on installations using the new oil system have led us to adopt it as standard for new construction. Net result is an independent oil system offering great reliability of operation (1) by protecting the lube-oil system at all times (2) by reducing to an absolute minimum the chance of main turbine tripping out because oil pressure was too low.

By IRA E CHURCH
Vibration Engineering & Balancing Service

Now—speed up those precision vibration-amplitude readings

VIBRATION METER reads amplitude of any wave shape directly at speeds above 500 rpm—no calculations are needed

Instruments that measure the root-mean-square (rms) values supply readings that can be used to calculate amplitude correctly only when vibration takes the form of a pure sine wave. This is one reason why the steam-turbine makers recommend that balancing be based on lateral shaft readings when possible.

It would seem that instruments that measure the movement mechanically, such as dial indicators and vibrating pens, would give a true value of amplitude. And at slow speeds these instruments are quite satisfactory. But because of the weight of the vibrating parts, I find they don't give true values at the higher speeds—1800 to 3600 rpm.

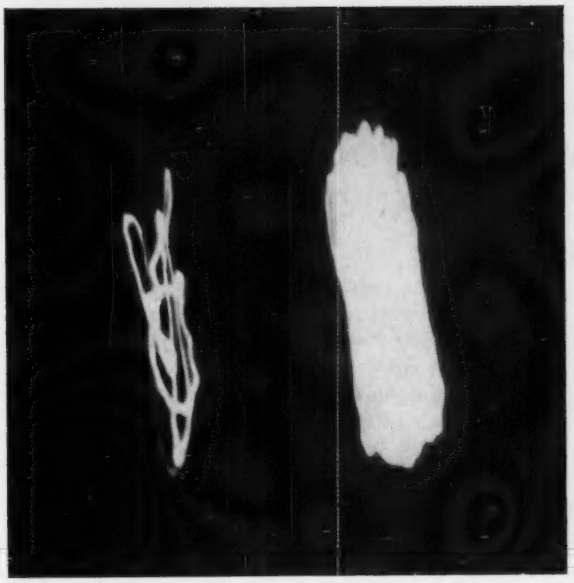
Light-beam vibrometer is used in most electric-power stations. But I find it neither accurate nor very useful at higher speeds, for two reasons. First: Since the destructive forces of vibration are proportional to the square of the speed, a smooth-running 3600-rpm turbine nevertheless shows bearing vibrations of about 0.2-mil amplitude (see p 236 of POWER's June '59 report, *Balancing Rotating Machinery*, for a vibration-tolerance chart). In general, the operator using a light-beam vibrometer can only estimate that vibration is less than half a mil, which might be just fair on the tolerance chart.

Second: It is almost impossible to hold the instrument steady enough to get a clear-cut reading. Unless the vibration is a pure sine wave, the band of light on the ground-glass screen shows shadings. Then the engineer has to try to evaluate this shading to get a correct reading of running-frequency vibration.

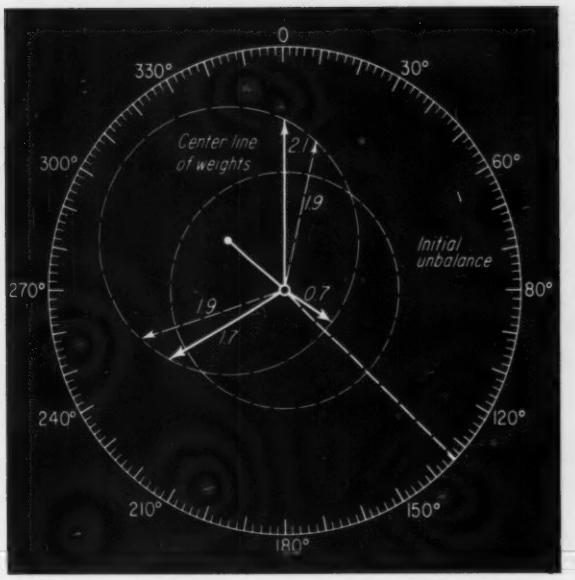
Trying to eliminate these difficulties, I mounted a light-beam vibrometer seismatically, in direct contact with a turbine bearing, and took photos of the mirror movement, center above. The first picture is a short exposure. The other is a longer exposure, such as you would see on a ground-glass screen. In the short exposure, individual cycles of 2-mil running frequency are visible. The longer exposure shows three mils, because other, lower-frequency vibrations were present. These combine to make high peaks at slow intervals of time, called beat frequencies, which the light beam will show.

I designed a vibration meter, photo, above left, for the express purpose of giving a true direct reading of vibration amplitude, of any wave shape, without calculation, for all speeds above 500 rpm. In designing this instrument, I used the characteristics of a magnetic seismic-vibration pickup and of transistors in an amplifying circuit.

In the usual seismic-vibration device there is a critical speed where excessive vibration of the spring-suspended coil takes place. As speed increases, vibrations drop in amplitude and gradually approach a constant value at higher speeds. My instrument almost eliminates that peak by a resistance across the coil which



SHORT AND LONG EXPOSURES were taken with ground-glass vibrometer mounted in direct contact with turbine's bearing



VECTOR DIAGRAM shows how motor's pulley was marked at points 120-deg apart. Modeling clay was shifted while balancing

acts as a damper. Resistance forms part of the input circuit of the first of four transistors in an amplifier, which boosts the reduced reading. An integrating circuit changes any velocity values to amplitude.

Transistors require an inverse feedback to compensate for temperature effects, which is why I designed this feedback. It gives a rising characteristic to the amplifier, as frequency increases, to match the decrease in pickup voltage. Thus a flat response is obtained for all speeds above the pickup's critical.

One advantage of the seismic pickup for measuring vibrations at turbine speeds: below the pickup critical, sensitivity drops off as the inverse square of the speed. Thus, at 500 rpm the meter reading is multiplied by ten to get the correct value of amplitude. In this way, low, unimportant frequencies are effectively filtered out of the readings.

Because of its accuracy and clear-cut readings, I use my instrument for single-plane balancing. Any machine that can be started and stopped easily for trial runs can be balanced by evaluating the effect of trial weights on the amplitude of vibration. Method works with fans, motors, flywheels, couplings and compressors.

In dynamic unbalance, a single-plane job can be done on each end. Vector diagram, above right, shows how I balanced a motor that drives a lathe. I stuck modeling clay to the inside of the driving pulley and to a pulley attached to the outboard extended shaft of the motor. Pulley was marked at three points 120-deg apart.

I took readings by moving the weight to each location, and in that way pinpointed the center line of the unbalance. Using this location, I added weight for balance. Then I took axial readings to check the dynamic unbalance. Shifting half the weight from the driving to the outboard end pulley reduced my readings from 1.9 to only 0.4 mils.

Obviously, this motor could not have been balanced so quickly and easily without precision readings. Important: these were amplitude readings, a true measure of unbalance. In many power stations, induced-draft fans, for example, need frequent balancing because of wear by flyash. In visiting plants around the country I have seen so much time needlessly wasted on this type of job. To date, I have used my speeded-up method to successfully balance motors after rewinding, pump runners after welding repairs, and motors, fans and centrifugal compressors that could not be opened for balancing.

EDITOR'S NOTE: *Ira Church wrote other articles on mechanical vibration for* POWER's *May, July and Aug 1950 issues. Because of the ever-increasing vibration and noise problem,* POWER *is preparing a special report on noise isolation. Besides the report on* Balancing Rotating Equipment *in June '59, see* Vibration Isolation, *Oct 1960.*

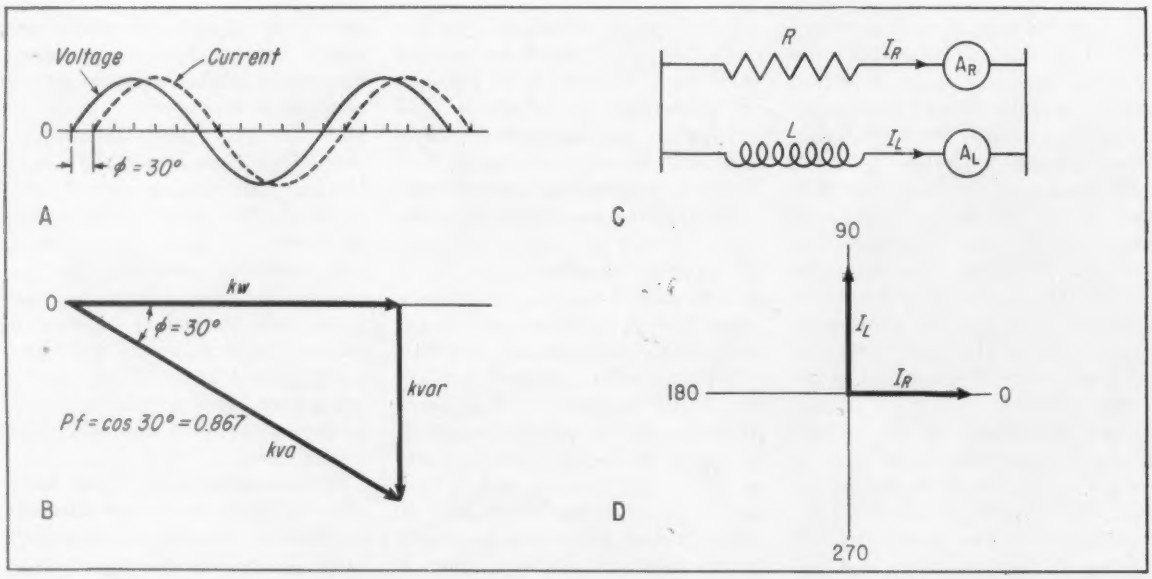
Plant Electrical Fact File

NO. 61: PF MEASUREMENT

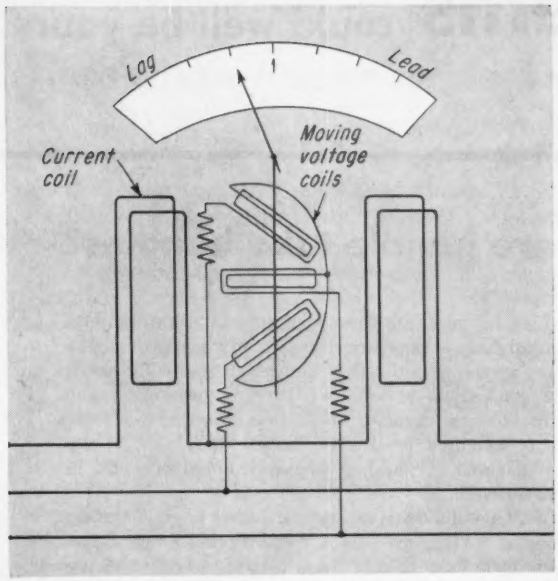
Ways to measure power factor and kilovars

By NORMAN PEACH, Associate Editor

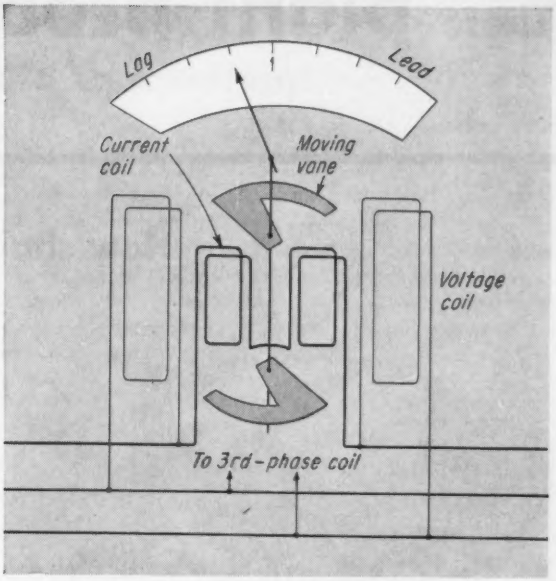
Power factor can be measured directly by the instruments shown at right, or you can calculate it readily from measurements made with ammeter, voltmeter and wattmeter. Power factor, the ratio of true power to apparent power, equals kilowatts/kilovolt-amperes, so you can also find it by measuring kilowatts and kilovars—$pf = cos\ \phi$, where $tan\ \phi = kvar/kw$. Kilovars (kilovolt-amperes reactive) represent the "reactive power" or non-productive part of the apparent power, expressed as *kv* x *amp*. Kilovars can be measured with a *varmeter*, fundamentally a wattmeter but modified as explained below. In *Fact File No. 20*, Dec 1957, we discussed how you can improve power factor by supplying kilovars from capacitors.



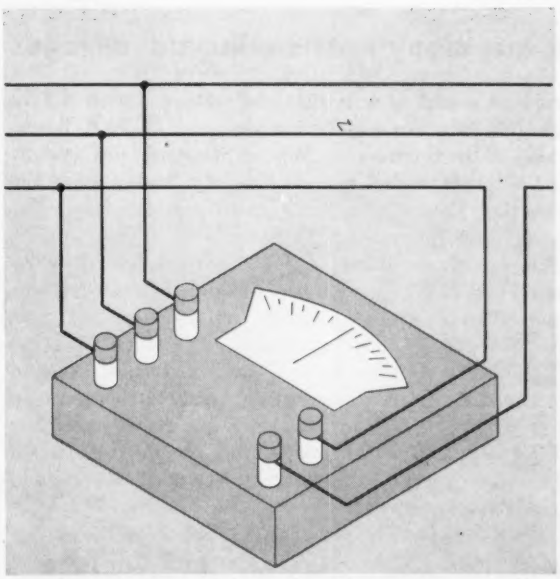
AC-POWER relationships are shown: Inductive circuit causes current to lag voltage (in *A* by 30 deg). Apparent power found by multiplying rms values of current and voltage is expressed as kva and forms an angle ø with the real power (kw). Closing the triangle, *B*, gives magnitude of kw, with kvar at right angles to it. *C* shows a circuit where *R* is pure resistance and *L* is pure inductance. This circuit causes I_L to lag I_R by 90 deg, so it is said to be *in quadrature*. You can make a wattmeter serve as a varmeter by substituting inductive reactance for resistance in the voltage circuit so that the moving-coil circuit is in quadrature with the impressed voltage



MOVING-COIL PF METER has stationary current coils, moving voltage coils. In 3-phase instrument, three coils are arranged on shaft with 120-deg displacement and with suitable series resistors. Single-phase instrument uses inductive phase-splitter and is therefore susceptible to changes in frequency while 3-phase instrument is not



MOVING-VANE PF METER has both current and voltage coils stationary. (For simplicity, third phase of phase-wound voltage "stator" is not shown.) Vanes of nickel-iron alloy line up with axis of combined fields—their shape minimizes errors. Single-phase unit uses phase splitter and voltage coil wound like a 2-phase stator

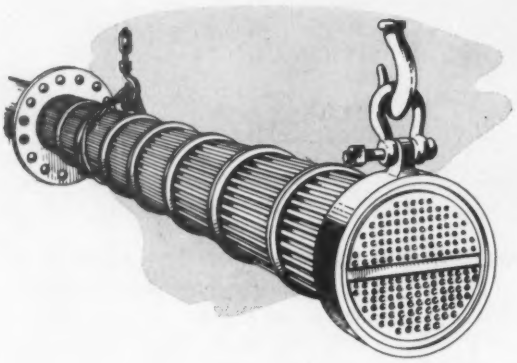


CONNECTING pf meter to a 3-phase line involves one series connection for current coil and three voltage connections. Hookup gives correct reading at all pf's. Polyphase pf meters are intended for balanced-phase circuits only. Single-phase pf meters should be used only at the calibrated frequency, usually 60 cycles per sec

CLAMP-ON PF METER avoids opening circuit for current connection. Designed for balanced 3-phase circuits, instrument measures both lagging and leading power factors, and determines phase sequence at the same time. Mechanism is modification of the iron-vane principle, but includes a potentiometer adjustment which you set by a dial

These **plant problems** could well be yours...

How should we handle tube bundles?



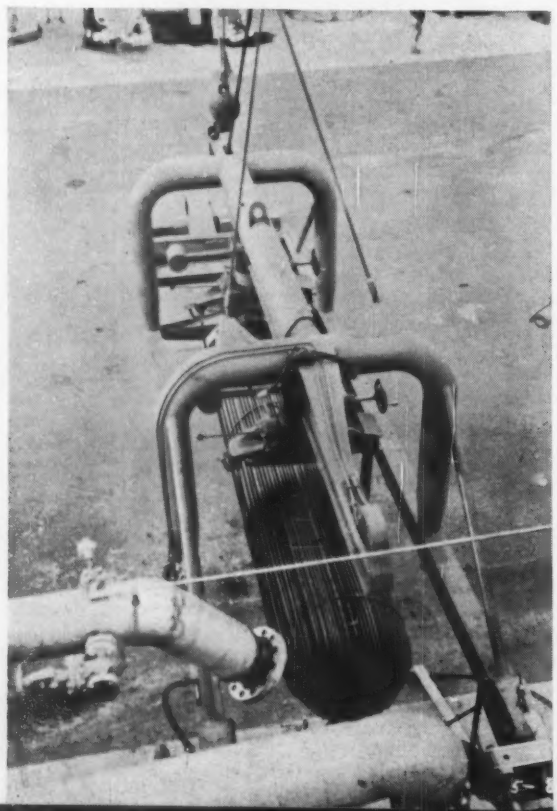
We are having trouble removing tube bundles from horizontal heat exchangers. Bundles, of the floating-head type, are 44 in. in diameter and weigh 20,000 lb. Shells are stacked three high. We have an overhead crane with hoisting capacity of 12 tons through two separately mounted cross-travel hooks. 12×12-in. beams are mounted on building steelwork opposite shells, in removal area.

We have difficulty supporting bundle weight during removal. Wire-rope slings bend tubes. Since transverse baffles are 42-in. apart it is hard to lay something across them to prevent tube bending. We used 5×1¾-in. channels, but these bent and dug into the tubes. In pushing the bundle back, we plowed a furrow in the shell. We are afraid any repetition of this will ruin the shells.

Can any reader tell us how to pull these bundles without denting them?—*KWB, June* POWER

Solutions...

Portable tube-bundle extractor has many cost-saving advantages



Machine shown at left is an elegant solution to *KWB*'s tube-handling problem. It was designed by W R Postlewaite, of the Engineering Dept of Standard Oil Company of California, and is manufactured by Southwestern Engineering Company under license from California Research Corporation.

On an elapsed-time basis, the portable extractor requires just 22% as long to take a bundle in and out as the average for a conventional crane and winch-truck system. The extractor and its crew of six men can pull or insert 14 bundles from 20-in. up to 48-in. in eight hours—based on mounting a second set of tube-bundle attachments on the next bundle ahead of the extractor. An average crew of 9.1 men for the conventional crane-and-winch system can pull or insert 3 bundles per 8-hr shift. Man-hour ratio on this basis is 6.9 to 1.

If a refinery shutdown involves 20 bundles, the extractor, at 1.12 hours per bundle "in-out cycle," will take 2.8 8-hr shifts. Average time for the conventional system is 5.05 hours per bundle "in-out cycle" or 12.7 8-hr shifts. During 12.7 days' elapsed time, the extractor saves 100 man-shifts that can be used elsewhere to effectively reduce the overall shutdown period. This reduction in shutdown time means important savings all around the plant.

...Here's how *Power* readers would tackle them

BOB MARKS, Associate Editor

Tube-bundle handling is much safer with the extractor and the degree of experience required is not too great. In comparison, the conventional system calls for a very experienced crew to handle mid-air transfer or dual-crane operation. Some refineries have very costly bundles weighing up to 28,000 lb, and handling can well be improved.

Another advantage of the extractor is that one crane can do the job, compared to the one to two cranes plus winch truck needed for conventional systems. The extractor saves about 13 8-hr crane shifts during a 12½-day shutdown. This heavy equipment can then be used effectively for other plant jobs to help shorten downtime and mitigate otherwise unavoidable bottlenecks. Besides, two 30- to 35-ton cranes are not always on call at a typical refinery for conventional tube pulling.

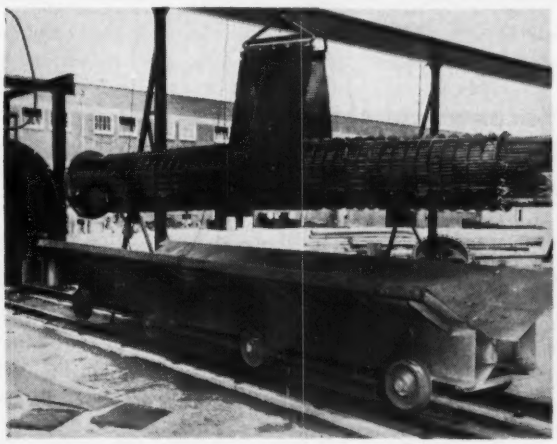
Ease and low cost of fast pulling offers the opportunity for more-frequent pulling, higher process efficiency.

Extracting-cable loads used with conventional systems may be dangerously heavy when applied to tight bundles in high structures. This is a serious problem and often requires the addition of portable or temporary braces to prevent structural damage, particularly when handling bundles in a running plant. Long 5/6-in. cables sometimes snap with loads of the order of 30,000 lb—this is recognized as a very bad personnel hazard.

An extractor also has advantages in emergencies, rapidly removing a bundle needing quick repairs and getting it back into service. This feature alone can save several plant days per year.

If *KWB* has enough heat exchangers in his plant calling for periodic bundle replacement he should seriously consider a machine of this type.

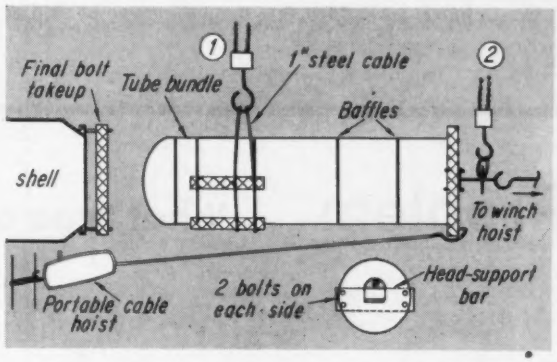
G B FAUST, *Los Angeles, Calif.*



Our plant uses woven-wire slings

Our plant has had great success with woven-wire slings. Sling in the picture above is 30-in. wide by 10-ft woven-wire length. This single sling has been used to lift bundles of 46-in. diameter weighing 14,500 lb.

Wire cloth of this type is readily available. Just specify the maximum load to be handled, type of hitch (basket or choke), whether one or two slings are to handle the load and the maximum temperature of any corrosive substances present.—G F MARTIN, *Houston, Texas*



This method solved our handling problem

I can understand *KWB*'s concern for his tube-bundle problems. We had similar troubles when we first started pulling and replacing reboiler bundles of about the same size—45-in. OD by 21-ft long with 600 to 700 tubes. Our bundles did have steel tubes, but we are retubing them with aluminum.

Arrangement we used is shown in the sketch. Our bundle heads have four studs. We mount the head-support pulling-bar on two of them, making the bar cross the head diagonally. When the bundle breaks loose enough to get a nut-head between it and the shell, four bolts are used to hold this bar solidly in the center.

We then put the No. 2 crane hook in the lifting eye and the winch line from an F-8 Ford to the pulling eye. The crane hook is rocked up and down and the trolley holding the crane hoists is moved back and forth sideways. This helps keep the bundle free during pulling or replacing. The truck is backed against the support for the overhead trolley track when pulling.

Bundle is pulled until the next to the last baffle shows. Then we attach the 1-in. wire-rope sling shown in the drawing. Sling is made endless by using four clamps, pushing a loop under the bundle and slipping that end over the hook eye. The other loop end is then drawn up over the eye from the other side, making a double line around the bundle. With this sling hanging loosely, we slip two oak 4x4's on each side against the baffles and slowly tighten the crane hoist. We keep the sling cables near to the baffle and as close together as possible. We place the timber so cable does not touch the tubes—an-

More **plant problems**

other timber may be needed towards the top.

Then we lower the bundle to a skid such as we use for retubing and hauling short distances from the shop. This skid has rubber-tired removable dual wheels.

Head-support bar is made from an 8-in. H-beam. Eyes of ¾-in. plate are welded at the center of the bar.

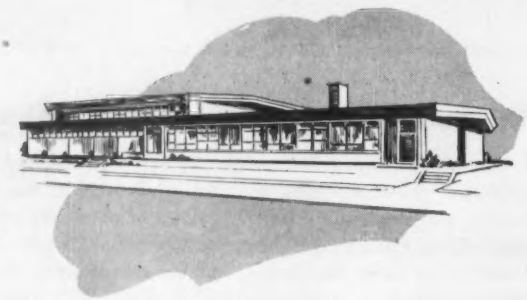
The new bundle is supported in the same manner. But the small hook of the portable cable hoist attaches to one of the small boltholes in the bundle head and is tied with a small rope before assembly is lifted above head-height. When bundle is at the correct level the cable hoist pulls the bundle into the shell. We operate the cable hoist from the walkway, just under the level line of the shell.

Winch line is also attached to the pulling eye of the bar when the bundle is going back in. If it sticks, one man can tug the slack winch line sideways to shake the bundle loose. After the bundle is pulled into position, the four regular studs are used to pull it to its final seat.

Skid rails inside the shell are greased to make the bundle slide easier. After it rests securely on the first baffle, we remove the sling and brace timbers. Plenty of play is still available with the No. 2 hoist hook and the trolley which keeps moving a little as the bundle goes back in.

With the new bundle on blocks on the ground ready to go in, we have been able to pull the old bundle, install the new one, put the head back on and have the exchanger in service in eight hours—assuming that everything goes smoothly.—J F MAHER, *Kirtland, N. M.*

Problem . . . **What type of heating is best?**



We are in the initial planning stage of a school expansion, a separate building housing gym, auditorium, shop and art room. Seating capacity of the auditorium is set at 1200.

Because of piping restrictions and placement of the new building it seems that a separate heating system is in order. If we do decide on a separate system, we aren't bound to make it the same as our existing one.

Our problem is an old one, but economic and engineering factors change so frequently we would like to bring our thinking up to date. Our question: which type of heating system is best for a load of this sort? The school is located in northern New England, and all areas may be used for community functions.

Can readers help us?—*LSM, June* POWER

Solutions . . . **Coal may be most-economical choice**

A great many facts have been left out which makes answering this problem a bit hazardous. We would like to know what fuel is most popular in *LSM*'s area, especially in these days, when oil and gas lines penetrate everywhere. But let's assume coal is still in vogue and either hot water or steam the rule.

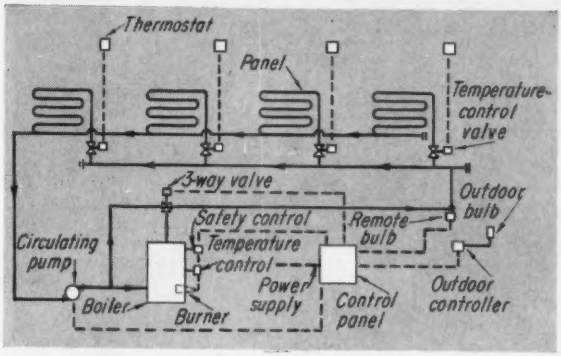
No doubt *LSM* knows that the economics of a small boiler plant can be greatly affected by the delivered cost of coal, even when the amount used is small. Coal should be considered on the basis of (1) suitability for use in the boiler (2) cost compared to the cost of the heat produced (3) delivered price. The coal should be so prepared and of such quality that a bare minimum of attention is required for continuous operation. This is particularly true in a plant of *LSM*'s size. Saving of labor and maintenance from a first-class prepared coal can more than pay for the higher grade. A balance has to be struck between keeping the fuel cost down and preventing maintenance costs from zooming.

We take for granted that a stoker is planned. Since stoker performance is improved by the use of uniform-size coal, this type should be specified in the invitation to bid. For small screw stokers a well-prepared double-screened coal or one containing not more than 25% through ¾-in. mesh is frequently justified.

Four principal factors enter into operating economy: (1) fuel cost (2) combustion and boiler efficiency (3) labor needed and (4) maintenance.

Again assuming that *LSM* burns bituminous coal with high Btu content, it is vital that this small advantage be

fully exploited and not lost through faulty plant design and operation. Starting from scratch it is possible to get high thermal efficiency consistent with low maintenance and operating-labor costs.—L HOBEN, *Oak Ridge, Tenn.*



Radiant-panel design has advantages

Assuming a new system including heat-generating facilities will be installed, an economic study should be made to select a design with the lowest overall annual cost. This should include fixed charges as a function of investment and direct cost related to fuel plus operating labor and maintenance expenses.

Due to the many activities in this new building, various rooms will have different heating loads occurring simultaneously. For example, the auditorium should have a dry-bulb temperature in the range of 72 to 74 F with a relative humidity of 35 to 40%. Temperature in the gymnasium should vary from 55 to 65 F with relative humidity of 15 to 25%. Temperature flexibility demanded by this type of installation calls for area zoning.

Normally the gym calls for relatively low dry-bulb temperature because of the physical activity taking place. But if the area is also used for exhibits, shows, dances and other less-vigorous activity, temperature must be higher during these periods. This involves changing the heat input by varying the thermostat. Same may be true in shops and art rooms.

Of the various types of comfort-heating systems available, a radiant-panel design using hot water deserves serious consideration. Both first and operating cost are competitive with other designs.

Locating heating elements below floors limits thermal gradients. This provides nearly uniform heating throughout the room, preventing drafts caused by high thermal differences. In addition, low surface temperatures limit body heat loss—a definite health advantage. My drawing, above, shows one typical hookup for such a system.

Other advantages of thermal radiant-panel heating include: (1) Eliminating radiators and convectors gives more space for occupancy. (2) Future interior alterations may be made with less interference. (3) There is less likelihood of tampering by school children. (4) Operating-fuel cost is lower because of lower air temperature along building perimeter. Heat loss through the building structure is also reduced because of smaller temperature difference between room and ambient air. (5) As soon as the building framework is completed the heating system may be installed—before construction is finished. This is of particular value in cold areas, since it allows the workers to stay warm while they finish construction. Increased efficiency and better workmanship usually result.

H B WAYNE, *Woodhaven, N. Y.*

Your September problems

What's wrong with our flowmeter?

Our southern textile mill has a 30,000-lb-per-hr combination oil- and gas-fired packaged boiler. The steam flowmeter is of the Ledoux bell type with a 120-in. head. Fluid in the meter body is water and mercury. At initial installation a static calibration showed it was accurate over the entire range. The meter was cut into service and operated without incident until the first time the boiler shut down. Then it wouldn't zero.

A routine check revealed air under the bell. When this was removed the meter zeroed perfectly. Again it went into service and operated without incident. But on the very next boiler shutdown the same thing happened. The meter would not zero and air was under the bell. This happens time and time again—air under the bell and a soft brown crud on the inside.

The copper tubing between the meter body and the orifice head pots has a minimum slope of 45 deg. The meter body was scrubbed out with steam and refilled with cold condensate, hot condensate, distilled water, etc. But the situation remains the same. Why does this take place? What is the cause? How can we prevent it from happening again? Perhaps other POWER readers have encountered and solved a similar problem.—*LAW*

How can we control boiler-water alkalinity?

Our plant has three 30,000-lb-per-hr boilers. Condensate return is variable and at times makeup requirements exceed the capacity of our hot-lime-soda water-softening system. During these periods we feed sodium-zeolite-softened water along with the output of the hot-process units. Our internal treatment consists of disodium phosphate, sodium sulfite and a corrosion inhibitor.

When zeolite-softened water is used alone as makeup or to supplement our hot-process system, boiler-water alkalinity becomes intolerable and at times gets completely out of range. The only solution recommended so far has been to increase blowdown on the boilers. This greatly increases the makeup and seems an expensive solution to our problem. How can we keep boiler-water alkalinity under control? Any information that other readers can offer will be greatly appreciated.

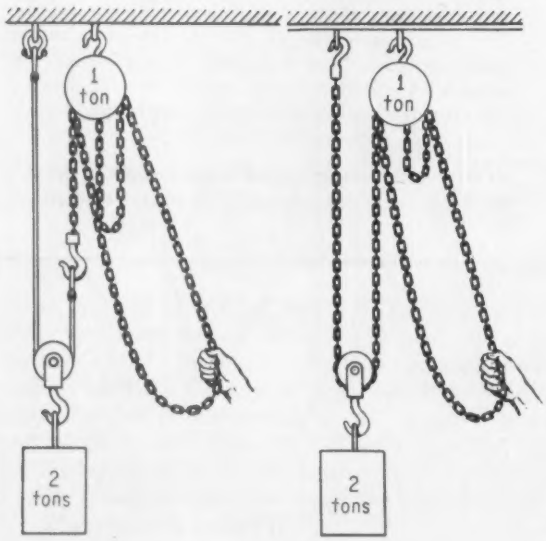
Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches

Timely **practical ideas** to help solve

Ultrasonic pickling cleans metal parts in jig time

Removing scale, oxides, plating stains, flux and other contaminants from large-gas-turbine components was a tough problem. But now these large units, photos, can be completely cleaned in a few minutes—they're pickled in large ultrasonic cleaning tanks.

The double-boiler arrangement of the inner tank uses steam coils to heat 30%-phosphoric-acid solutions to any desired temperature. There are similar coils in the outer tank, and they carry cold water to keep pickling solution and transducers cool. A new generator drives the eight transducers, which convert electrical impulses into mechanical vibrations. So in this plant, ultrasonic cleaning did the trick.—*Courtesy, Avco Corp, Stratford, Conn.*



How we coax a chain hoist into lifting double weight

Sketches show two methods of doubling up the lifting capacity of a chain hoist. In the shop, increasing lifting capacity often lets a job be done immediately.

Sketches show how you can lift twice the load with an extra block. With method in right-hand sketch, the load can be lifted to the full height. Use this method if the chain is long enough to reach back up to the support. Left-hand sketch shows how we use a second block and a length of cable. Here, of course, the load can be raised only until hook reaches chain block.—H Koslow, *Bronx, N.Y.*

your tricky design and maintenance problems

STEVE ELONKA, Associate Editor

Water vapor stops soot

In my many years as a marine engineer on ocean-going ships, I have experienced soot at its worst. But I feel there is one simple and effective way to reduce soot and ash from boilers. At present I am on a *C-3* freighter with steam-atomizing burners. These burners go a long way toward cutting down the soot, but will not eliminate it entirely.

Before the steam atomizers we used mechanical atomizers. They gave us serious soot problems. We had to blow soot twice a day, and our decks were covered with it after each blowing. With the steam atomizers installed, we blew tubes but once a day and very little soot came out.

Some operators use a soot-removing chemical powder to blow into the furnace, but I don't like this unless the chemical can be blown into the boiler continuously during operation.

I found a very simple, relatively inexpensive way of getting the same result that the steam-atomizing burners produce. That is: introduce a small amount of water vapor from a low-pressure steam line to the boiler's windbox. It blows into the furnace with the combustion air to mix with the furnace gases.

I tried this on another *C-3* I was on and it worked excellently. After I installed a small steam connection to each boiler windbox, we blew tubes only once a day and had hardly any soot showing in the stack gases. I used a special nipple to the windbox with only a 3/32-in. hole through it as I wanted to conserve water.

Of course, I did all this 12 years ago—we were getting fuel oil of a better quality than we do today. This same ship is still using my system and still blowing tubes just once daily, but soot does come from the stack, though not nearly as much as before. The same is true of the ships converted to steam atomization: at first they showed no soot whatsoever in their stack gases; today they do. I think the culprit is a poorer grade of oil with more incombustible matter.

H L ENGSTROM, *San Francisco, Calif.*

What would you have done?

During World War II, I was engineering-division officer on a 12,000-ton carrier. We had two uniflow steam engines. Cylinder lubrication, and plenty of it, was a must. But then the condensate had to be well filtered to keep oil out of our boilers.

When the filters became coated with oil, we'd backwash them with sea water piped directly from a 6-in. manifold welded to the ship's side. But this skin valve developed a bad leak and there was no shutoff valve between it and the hull. Our condensate was being contaminated to the danger point.

Removing that valve should have been a shipyard job. We couldn't wait that long, so I rounded up our best men, outlined the work, assembled all the gear needed and rigged a heavy tarpaulin in the form of a tent over the manifold to keep the 27-ft head of sea water that would gush up from shorting our electrical equipment.

We made a blank flange to replace the bonnet after it was removed. We slacked the bonnet nuts, meanwhile holding down the bonnet with a lever until all nuts were off. Then the bonnet blew off, and we started the bilge pump.

After a thorough bath inside the tent we had the blank in place and the valve up in the machine shop. Two deep grooves across the seat were removed in the lathe. But the valve disk had a ¾-in. tail guide 4-in. long. We pointed the tail and removed ⅛ in. from its diameter. This guide would have to be fitted into the web of the seat ring against that 65-psi gusher.

Three of us almost got skinned but we still didn't have the bonnet in place. Finally we replaced the blank and cut off the tail guide, meanwhile praying that the disk would seat without it. The tent had to be reinforced. But this time we made it, and the valve didn't leak when it was shut. What would *you* have done?

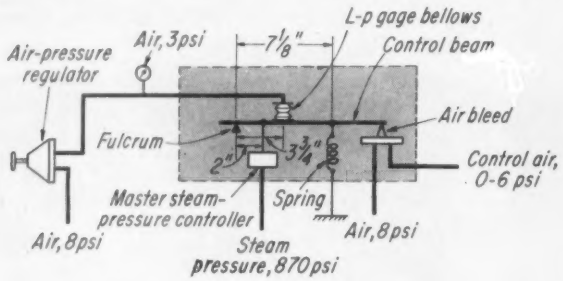
W B LAUGHINGHOUSE, *Havelock, N.C.*

Did you know . . .

that induced-draft fans are usually designed and tested on the basis of performance with air? This is possible because flue gases developed by burning low-hydrogen fuels have almost the same characteristics as air for fan performance. When handling gases resulting from combustion of high-hydrogen fuel, such as natural gas, a slight correction is needed. Reason: the increased water-vapor content gives a slightly greater volume per lb.

Forced-draft fans are tested at prevailing barometric pressure and air temperature. Then corrections are applied for any differences that may be found.

L V ANDREWS, *Dunedin, Fla.*



Here's how we improved our master steam controller

My sketch shows an improvement we made on the master steam-pressure controller for our No. 1 boiler. We did this because each time the boiler was out of service for any length of time its spring tension had to be adjusted to get it back on automatic control. When adjustment wasn't made, we had to wait about six hours for the pressure in the steam-gage line to the controller to adjust to a water leg. That wasn't practical.

We raised the air pressure in the bellows to 3 psi, which is mid-range on the 0-to-6-psi gage. Then we decreased the spring tension so it holds the same control-air output.

To improve the controller, we used a low-pressure gage bellows mounted on top of the control beam, then installed an air-pressure regulator to supply air to the bellows. This regulator was mounted in an old selector with a gage. We find that a 1-psi change in the bellows pressure changes the steam pressure by 10 psi.

We also use this improved controller to run efficiency tests on the unit at different steam pressures. For example, now we can go from 850 to 890 psi by changing the air pressure in the bellows from 1 to 5 psi. So this instrument is very helpful, especially when bringing the unit online in our steam-electric plant.

G F BRILL, *Lake Charles, La.*

Metalizing pays—and cuts our spare-parts inventory

All power plants are interested in keeping their stock of spare parts to a minimum. We purchased metalizing equipment so that our worn parts could be rebuilt, thus cutting down on spares. We paid about $1500 for the unit with the necessary weld wires—but were able to cut over $1000 from existing purchase orders. Now, when we take a pump or other piece of equipment down for repair, our welder rebuilds the parts almost as rapidly as the maintenance crew can clean up and reassemble the unit.

Many times the rebuilt part is better than the original. Hard stainless steel can now be sprayed on the bearing surfaces of a shaft. We often make our own stainless-coated shafts at greatly reduced costs. It is a good investment, even in a one 15,000-kw turbine plant.—K M WHITE, *Chamois, Mo.*

My biggest boner

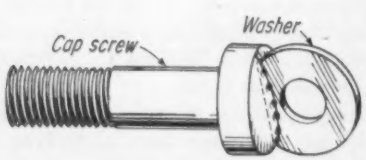
I was making an internal inspection of one of two watertube boilers; the other was under pressure. Boilers were of the cross-drum box-header type, with blowdown lines from water columns and headers connected to one common drain line.

Being on my first visit, I made it a point to meet the chief engineer. But he was called away before I could enter the boiler. So I went ahead, checking the blowoff valves on the cold boiler to make sure they were all closed. Then I started into the manhole. But just as I got my head and shoulders in, it occurred to me that maybe I had better let someone know I was in the drum.

That decision saved my life, for just as I backed out of the opening, the fireman opened the blowdown valve on the hot boiler.

I had failed to notice the boiler drum had a surface blowdown line which was open. Live steam belched through this line as the hot boiler was blown down, flooding the drum I had just vacated. Had I been in there I would have been boiled like a lobster.

Since then, I don't enter a boiler without first notifying the proper personnel. If the boiler is part of a battery of hot boilers, I check all blowdown and main-steam stop valves. I hang "Danger, man in boiler" signs on the hot boilers. When I climb in, I want to be sure I'm making a round trip.—L LEFLER, *Fort Worth, Texas*



Make up your own adjusting screw like this

When you need a thumbscrew or an adjusting screw in a hurry you can make one up for yourself, sketch. Take a slotted screw, then cut a flat on one side of a washer and insert it in the slot. Hold the washer in place by center punching as shown. If you like, you can solder or braze the washer in place. These thumbscrews are very handy.—H KOSLOW, *Bronx, N.Y.*

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1—Babcock & Wilcox	—122,000 #/hr—	—250 psi
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1—Babcock & Wilcox	—100,000	—450 psi
1—Babcock & Wilcox	— 90,000	—245 psi
1—Combustion-Engineering	— 75,000	—250 psi
1—Riley	— 70,000	—250 psi
2—Babcock & Wilcox	— 70,000	—450 psi
1—Riley	— 60,000	—250 psi
2—Combustion-Engineering	— 50,000	—250 psi
1—Babcock & Wilcox	— 45,000	—450 psi
1—Combustion-Engineering	— 40,000	—220 psi
1—Foster-Wheeler	— 40,000	—200 psi
1—Babcock & Wilcox	— 35,000	—300 psi
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1—Babcock & Wilcox	— 27,500	—450 psi
2—Riley	— 19,000	—200 psi

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88,000 LBS/HR

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50 hp. Mund Scotch Marine package, oil, 125 psi, fully automatic, new, unused (7)
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175 hp. Comb. Engr. package 375 psi., oil, automatic
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500 hp. Cleaver Brooks, package, 150 psi., oil automatic
300-600 hp. Bigelow Scotch Marine Boilers, 3,000 sq.ft., 200 psi, complete package units, automatic, etc. (1955) (3)
600 hp. B&W, 200 psi., 3 drum, assembled, unused.
10,000 lbs/hr., B&W, package watertube, 2100 psi, oil, compl. (exc. for testing purposes)
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175,000 lbs, C Engr., 950 psi., 2 drum, stoker and oil, superheat, etc. Completely installed new 1954. All 2½" Tubes.

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500 KVA TRANSFORMER, General Electric #1529, oil type, 3 phase, 60 cycle, 4160Y volts primary, 240-480 volts secondary. Late mdl. Excellent. $1000

VARI SPEED CONTROL, Reliance, No. 015V-S. 220/3/60 & 52 amps. or 440/3/60 & 26 amps. For 15 hp. motor. Late mdl. & excellent. ¼th new price. $1250

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SAME PRICE FOR EITHER RIVETED OR COTTERED TYPES

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EXAMPLE
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89¢ per ft.
(Consumer price)

1. High quality, imported.
2. Manufactured to American Standard Specifications.
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4. 10 ft. lengths individually packaged.

DEALERS: Here is the ideal roller chain for you — low cost, high discount. Additional discount if shipped direct from source.

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(4) NEW 500 KW GM 8-278

Engines — 715 HP — Vee type — 8 cylinder — 8½ x 10½ — air starting — 720 RPM — 2 cycle — heat exchanger cooled. Engines drive 500 KW Allis-Chalmers D.C. generators—120/240 — 2080 amps — 720 RPM — compound wound. Complete with a very generous supply of spare parts. IF YOU NEED D.C. POWER, NOTHING CAN BEAT THIS VALUE. FULLY GUARANTEED.

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138 CFM	100 PSI	7x7, Ing. ES, CP & Joy
258 CFM	500 PSI	9½-4¼x11 Ing. ES2 (New)
268 CFM	100 PSI	9x9 Ing. Worth. CP
321 CFM	125 PSI	10x11 Ing. ES-1
344 CFM	1500 PSI	Ingersoll ES-3
380 CFM	40 PSI	12x9 Gard. (New) Ethylene
456 CFM	350 PSI	12-6x13 Worth HB2
485 CFM	100 PSI	12x11-1R-ES-1° Chic. P.T.
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670 CFM	125 PSI	15-9¼x12 Ing. XRE 125 Syn. 3-60-440-277 RPM
686 CFM	100 PSI	14x13 Ing. ES
1855 CFM	100 PSI	23-14x14 Ing XRE 300 HP GE Syn 3-60-440 (2) 1952
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2. 15CFM, 5000 Psi,—4 Stage, Air Cooled, 15Hp 220/440 Volt Portable.
1. 155CFM, 100 psi, 8x8, 30 HP 220/440 volt motor.
2. 700CFM 35 psi, 11x16x14, Steam Driven.
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LIKE NEW . . . RECTIFIERS AT 75% OFF COST

FOUR 1100 KW ALLIS-CHALMERS MERCURY ARC RECTIFIERS total 4400° KW, 16000 AMP, 3/60/33000/4160/2300 to 275-86 Volts complete with Automatic Controls • 4—1320 KVA OISC Transformers 3/60/4160-277 Volts with Inter-Phase Reactors • 2—4475/6925 KVA OA/FA REGULATING TRANSFORMERS 3/60/33000—4160 with 2300 tertiary winding and remote controlled tap changers.

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24750 CFM Ingersoll-Rand Centrifugal Blower Type MTA465 4 Stage 27 PSIG Discharge Pressure 5100 RPM driven by Worthington 2600 HP Steam Turbine 125 PSI at 450°F.

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4840 CFM Carrier Centrifugal Compressors 8100 RPM Suction Pressure 149.7 PSIA, Discharge Pressure 239.7 PSIA driven by 2066 HP Terry Turbine, Condensing, 430 PSI at 560°. (2 units)

3000 CFM Ingersoll-Rand PRE2 Compressor 125 PSI Discharge 33" & 20½" x 24" driven by 700 HP 3/60/2300 V. Synchronous Motor.

1360 CFM Worthington YO Compressor 35 PSI Discharge 15⅜ & 15⅜ x 7 direct connected to 150 HP 3/60/2200/590 RPM Louis Allis Explosion-Proof Motor.

604 Ton Carrier Freon 11 Refrigeration Compressor with Condenser and Cooler driven by 639 HP Terry Turbine 430 PSI Condensing.

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UNIT SUBSTATION — NEW 1956

2174 KVA General Electric Type OA (2500 KVA with forced air), 33,000 Volt Primary, 2400 Volt Secondary, 3 phase, 60 cycle, 1200 Amp, 2.4 KV, 50 MVA Drawout Circuit Breaker with Relays, Ammeters, Voltmeter, Control Switch, etc.

SINGLE PHASE — 60 CYCLE — OISC

2000 KVA West.	13800 Volt Primary 2300 Volt Secondary (4)
1000 KVA G.E.	13800 Volt Primary 460 Volt Secondary (3)
500 KVA Wagner	66000 Volt Primary 460 Volt Secondary (3)
500 KVA West.	2300 Volt Primary 440 Volt Secondary (3)
200 KVA West.	2300/4160 Y Primary 440 Volt Secondary (3)
150 KVA G.E.	2400/4800/8320 Y Pri. 240/480 Volt Sec. (3)
75 KVA Wagner	4600 Volt Primary 115/230 Volt Secondary (3

THREE PHASE — 60 CYCLE

3750 KVA G.E.	33000 Volt Primary 2400 Volt Secondary NEW 1956
2000 KVA Al.Ch.	33000 Volt Primary 2300 Volt Secondary NEW 1956 (2)
1250 KVA G.E.	2400/4160 Y Primary 240/480 Volt Secondary
750 KVA G.E.	4160 Volt Primary 480 Volt Secondary
450 KVA West.	13800 Volt Primary 460 Volt Secondary (6)
150 KVA West.	2400 Volt Primary 240/120 Volt Secondary 25 Cycle Hypersil
112.5 KVA G.E.	2400 Delta Primary 240/480 Volt Secondary-Dry Type

FURNACE — 60 CYCLE — SINGLE PHASE

2500 KVA G.E.	13200 Volt Primary 95 to 155 Volt Secondary (6)
2500 KVA West.	11500 Volt Primary 95 to 125 Volt Secondary (3)
2000 KVA West.	13200 Volt Primary 120 Volt Secondary NEW (3)
5000 KVA West.	2300 Volt Primary 100 to 249 Volt Secondary—Three Phase

FURNACE —25 CYCLE — SINGLE PHASE

4450 KVA G.E.	11000 Volt Primary 80 to 140 Volt Secondary (3)
2500 KVA West.	10000 Volt Primary 70 to 140 Volt Secondary
750 KVA G.E.	12000 Volt Primary 45 to 60 Volt Secondary

GENERATORS

(2) 750 KW General Electric Motor Generator Sets Synchronous Motor Drive 1100 KVA 900 RPM Type TS 3 Phase, 60 Cycle, 2200 Volt Direct Coupled to 750 KW Type MPC8 Generators 3000 Amp 250 Volt with enclosed AC and DC Controls.

(1) 500 KW General Electric Non-Condensing Turbo Generator 265 PSI Initial Pressure 10#BP 3/60/480 Volt 3600 RPM.

(2) 1250 KVA General Electric Condensing Turbo Generator 200 PSI 1000 KW 3/60/2300 Volt 3600 RPM.

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Complete with Meters & Relays

1200 Amp Westinghouse Type 345CA
1500 MVA 34.5 KV Drawout Breakers (8)
2000 Amp Allis-Chalmers Type AM150C
150 MVA 4.16 KV Ruptair Drawout Breakers (2)
1600 Amp Allis-Chalmers Type G50A
50 MVA 600 Volt Drawout Breakers (4)
600 Amp Allis-Chalmers Type G25
25 MVA 600 Volt Drawout Breakers (9)

D.C. CIRCUIT BREAKERS

(3) 2000 Amp 125 Volt Single Pole Air Circuit Breakers manual closing, on Panelboards.

AUTO TRANSFORMER

1950 KVA Oil Insulated 3/60/2300 V

MOTORS

230 VOLT DC MOTORS

HP	MAKE	TYPE	SPEED	WINDING
150/200	G.E.	MDS418AE2	730	Series
75	G.E.	MD414AE	475	Series
75	CR.WH.	CCM	850/1060	Comp.
45	G.E.	MD410AE	550	Comp.
35/45	G E.	MD410AE	525	Series
33	G.E.	MD408AE	625	Comp.
15/19	G.E.	MD406AE	650	Series
6/10	G.E.	CD85	850	Shunt
5	G.E.	MD403AE	700	Comp.

CLASS I GROUP D — 3 PHASE 60 CYCLE

HP	VOLT	RPM	
350	2300	3600	
250	2300	3600	(3) 1 NEW
250	2300	710	
200	2300	3600	
150	2300	3600	
125	2300	1800	
100	2200	3600	

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53 YEARS SERVICE

MOTOR GENERATOR SETS

Qu.	KW	MAKE	RPM	AC VOLTS	DC VOLTS
2	4800	G.E.	450	2300/4600	250/300
1	2500	WHSE.	720	2300/4160	600
1	2100/2400	G.E.	450	2300/4600	250/300
2	1750/2100	G.E.	514	2300/4600	250/300
1	2000	G.E.	514	2300/4600	600/666
1	1500	G.E.	720	13200/6600	600
1	1250	WHSE.	720	2300/4000	600
1	1000	G.E.	900	2300/4000	600
1	1000	G.E.	900	6600/4000	280
1	1000	G.E.	720	2300/4000	275
1	500	G.E.	900	2300/4600	250
1	500	G.E.	900	440	250/125
2	300	G.E.	1200	2300	275
1	300	WHSE.	1200	2300/4100	600
1	200	G.E.	1200	2300/4160	250

FREQUENCY CHANGER SETS

Qu.	KW	MAKE	FREQ.	VOLTAGES
1	12500	WHSE.	60 To 25	13200-13900
1	5000	G.E.	60/50/60	11000-6600
1	2500	G.E.	60/24/60	2400-2400

3 PHASE 60 CYCLE MOTORS SLIP RING

Qu.	HP	MAKE	TYPE	VOLTS	SPEED
1	1750	G.E.	M-570B8	4800/2400	1800
1	800	WHSE.	CW	550/2300	1776
1	600	WHSE.	CW-32D	440	1775
1	600	WHSE.	CW	440	850
1	550	WHSE.	CW	440	252
1	500	WHSE.	CW	2300	881
1	500	WHSE.	CW	550/2300	359
1	300	AL. CH.	ANY	2200	720
1	300	GEN. EL.	MTP-561	2200	1760

SQUIRREL CAGE

Qu.	HP	MAKE	TYPE	VOLTS	SPEED
3	1500	G.E.	K.D.P.	2300	3589
1	1000	AL. CH.	ANW	2300	1180
1	550/275	WHSE.	CS-1115	2300	863/445
2	500	WHSE.	CSP-583H D.P.	440	3600
4	500	AL. CH.	ARW-D.P.	2300	3600
2	450	EL.	FR3910	2200	1185
1	400	WHSE.	CS7151	6600	3565

OUTDOOR G.E. METAL CLAD SWITCHGEAR

600 V. 3 POLE, A.C.B.

1—3000 AMP., AL-2-75, ELEC. OPER
1—1000 AMP. AL-2-50, MANUAL
4— 800 AMP, AL-2-50 MANUAL
1— 400 AMP., AL-2-50 MANUAL
3—SPARE COMPARTMENTS

PUMPS — MOTOR DRIVEN

4—600 G.P.M. Gould, Figure 3360, 8 Stage, 2310 Ft. Head, 1000#, 3550 RPM, Each coupled to 500 HP 3-60-3350 RPM D.P. Sq. Cage Motor

2—WHSE, Type CSP-583H, 440 volt

1—Allis Type 2300 volt Magnetic Encl. Reduced Voltage Starters

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Phone: OL 3-3334—N.Y.C. RE 2-7150

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A. C. MOTORS—60 CYCLE

HP	Mfr.	Type	Volts	Speed
800	Whse. (2)	Sq. Cage	2300	1800
750	El. Machy.	Synch.	480	514
700	G.E.	Slipring	2300	400
700	G.E.	Slipring	2300	514
600	G.E.	Synch.	480	900
600	Elliott (2)	Sq. Cage	2300	900
600	Whse.	Slipring	2300	360
500	G.E.	Slipring	2300/4000	514
500	G.E. b.b. (2)	Synch.	2300/440	1200
450	Allis Ch.	Sq. Cage	2300/440	720
400	Allis Ch.	Slipring	2300	900
400	Whse.	Sq. Cage	2200	514
400	Marathorn (2)	Sq. Cage	2300	3600
400	G.E.	Slipring	2200/440	600
400	G.E.	Synch.	550/2200	400
400	Whse.	Sq. Cage	440	1200
350	Allis Ch. (2)	Slipring	2300	450
350	G.E.	Slipring	440	900
350	El. Machy.	Synch.	2300	900
300	G.E.	Slipring	220/440	514
250	G.E.	Sq. Cage	440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	Whse.	Sq. Cage	2300/440	600
250	Whse. (4)	Slipring	2300/440	600
200	G.E.	Slipring	550/440	1200
200	G.E. b.b.	Sq. Cage	220/440	720
200	G.E.	Slipring	220/440	450
200	G.E.	Slipring	440	600
200	G.E.	Slipring	2200	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	2200/440	720
200	G.E.	Sq. Cage	2300	450
150	Whse. b.b.	Sq. Cage	440	1800
150	Whse. XP	Sq. Cage	440	3600
150	G.E. (4)	Slipring	2200/440	600
150	Whse.	Slipring	220/440	1200
150	G.E.	Sq. Cage	2200/440	600
125	Star b.b.	Sq. Cage	220/440	900
125	A.C. TEFC	Sq. Cage	220/440	1800
125	El. Machy (2)	Synch.	220/440	400
125	G.E. TEFC	Sq. Cage	2200	3600
125	Al. Ch. TEFC	Sq. Cage	220/440	600
125	G.E. (2)	Slipring	220/440	514
125	Whse. b.b.	Sq. Cage	220/440	3600
100	Star b.b.	Sq. Cage	220/440	600
100	Allis Ch.	Slipring	2300/440	600
100	Al. Ch. TEFC	Sq. Cage	2200	1800
100	G.E. TEFC	Sq. Cage	220/440	1200
75	A.C. TEFC	Sq. Cage	2300/440	1200

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
350	G.E.	MPC	250	900/1200
250	Cr. Wh.	101-E	250	1150
200	Whse. b.b.	SK	250	287/575
150	Reliance b.b.	1050-T	230	1150
150	Rel. TEFC b.b.	2550-F	230	850
125	G.E.	CD-173	230	575/1150
100	Reliance b.b.	1050-T	230	600/1200
100	Elliott b.b. T.E.	JH-FE	230	1150
100	El. Dyn. b.b. (2)	30-S	230	450/1200
75/100	Whse.	SK-191	230	300/900
60	G.E. TEFC b.b.	CD-135	230	1150
40/50	Whse b.b.	SK-173	230	300/1200

MOTOR-GENERATOR SETS

KW	Mfr.	Input	Output V
600	Allis Ch.	440 AC	250 DC
300	G.E.	440 AC	250/350 DC
200	Allis Ch. (2)	440 AC	250 DC
200	Whse. synch.	220/440 AC	55 DC
200	Gen. Elec.*	220/440 AC	125 DC
100	Delco b.b.	220/440 AC	120/240 DC
75	Whse. Synch.	220/440 AC	250 DC
75	Elec. Prod.	220/440 AC	125 DC
50	G.E.	220/440 AC	250 AC

Arthur Wagner Co.

Certified

MO nroe 6-7409

1435 W. RANDOLPH ST

CHICAGO 7, ILLINOIS

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POWER EQUIPMENT

1500 KW, Elliott, Cond. Turbo-Gen. 3/60, 2300 V., 5000/1200 RPM, 250-400 PSIG, 525°-750°TT.

1000 KW, West. Cond. Extr. Turbo-Gen. 3/60, 245/490 V., 3600 RPM, 130-230 PSIG, 386°-500°TT, 10# Extr.

625 KW, West. Non-C. Turbo-Gen. 3/60, 480 V., 3600 RPM, 200 PSIG, 5-12 PSIG Exh.

1000 KW, G.M. 16-278A, Diesel Units (2) 3 ph. 60 cycle, 2300 V., 720 RPM.

750 KW, G.M. 12-567A, Diesel Units (3) 3 ph. 60 cycle, 2300 V., 720 RPM.

300 KW, G.M. 8-268A, Diesel Units (2) 3 ph. 60 cycle, 480 V., 1200 RPM.

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& COMPANY, INC.

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75 TON BRIDGE CRANE

1—75 Ton capacity Whiting Mfg. Co. bridge crane with auxiliary hoist, 51 ft. span, complete with operating motors, control and rail.

Excellent condition.

Can be inspected in operation.

UTILITIES MACHINERY CORP.

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TRANSFORMERS

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WORLD'S LARGEST INVENTORY
CALL COLLECT CL 4-9058
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FOR SALE . . . LARGE DIESEL GENERATORS

A complete 16,470 K.W. modern power house is offered in its entirety with plant equipment common to all units.

OR

Units may be purchased separately with all switch gear and accessories necessary for individual operation.

This equipment was purchased new from the respective factories for temporary power on our Glen Canyon Dam Project and the town of Page, Arizona until public power was made available. They have seen limited service and are in excellent condition.

Plant consists of:

Four 1360 K.W. Fairbanks Morse 4160 volt, 60 cycle, 720 r.p.m. generators direct connected to 12 cylinder model 38D8⅛ opposed piston diesel engines. Individual radiator cooled. Units put on line in 1958.

Ten 1103 K.W. "English Electric Company of Canada" 4160 volt, 60 cycle, 720 r.p.m. generators direct connected to "English Electric" model 16SV exhaust turbo-charged 16 cylinder diesel engines. Individual radiator cooled. Units put on line in 1958 and 1959.

FOUNDED 1860

All units still on original foundations.
Subject to inspection and prior sale.

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For further information contact! Zim T. Pearce—Mgr. of Equipment Sales.

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386

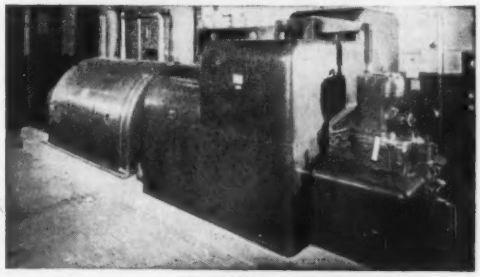
Modern 850lb. 850°—6250 K.V.A. Turbine Generator

80 to 160 lb. Back Pressure

Immediately

Available

Excellent Condition



Actual Photograph

Generator

3/60/2400, 80% P.F.

Built by Westinghouse

Other turbine Generators

1-2000 KW GE	600# 750° Non-Cond. 150# BP 4160/6600V
1-3000 KW Westinghouse	600# 700° Non-Cond. 50/125# BP 2400V
1-3000 KW Westinghouse	400# 750° Cond. 6600/4160V
1-2500 KW Westinghouse	125# Non-Cond. 10# BP 2300V
1-6000 KW GE	200# Condensing 2300V
1-7500 KW Allis-Chalmers	850# 850° Non-Cond. 110# BP.

Cable Address: CHASWEAVER

CHARLES WEAVER, INC.

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DETROIT 35, MICHIGAN

Telephone: BRoadway 3-1900

Circle 520 on Reader Service Card

DIESEL GENERATOR SETS

Stationary, Portable, Mobile

KVA	MAKE
1875	FM33F16*
1562	Superior Mod. 80
1420	FM 38d8⅛
1375	GM 16-567C*
1375	GM 16-278A
938	GM 12-567*
625	GM 8-278A
625	Worthington EE6
437.5	Enterprise DSG-6
375	GM 8-268A
125	GM 3-268A

*Diesel or Dual Fuel Units

Units offered with one-year guarantee

Turnkey Installations

A. G. Schoonmaker Co., Inc.

Dept. D, Box 516 Sausalito, Calif.

Circle 521 on Reader Service Card

ELECTRICAL POWER EQUIPMENT

SLIP RING MOTORS

HP	RPM	MAKE	VOLTS	TYPE
2500	257	G.E.	6600	MT-28
1000	1200	Al.-Ch.	4000	ANY
1000	900	Al.-Ch.	2300	ANY
700	720	G.E.	440	I-M
600	1800	G.E.	4160	M-6345
500	1200	G.E.	440	M-6345Z
400	1200	West.	2300	CW
400	720	G.E.	440	MT-573Y
350	1800	Al.-Ch.	2300	ARYW
300	900	G.E.	440	IM-17
300	450	G.E.	440	IM-16
250	600	West.	2300	CW-1000
200	514	West.	2300	CW-950A

MOTOR GENERATOR SETS

KW	MAKE	A.C.V.	D.C.V.
1750	G.E.	4160/2300	250/300
1250	West.	4160/2300	250
1000	West.	4160/2300	250
750	G.E.	4160/2300	250
600	G.E. (3 unit)	2300/440	125/250
500	G.E.	2300	250
400	Al.-Ch.	2300/440	125/250
250	G.E.	2300	250
200	G.E.	2300	250
150	West.	440	250

D. C. MOTORS

HP	RPM	MAKE	VOLTS	TYPE
1500	300	West.	250	TEFV
850	250/500	West.	250	QM
600	250/500	G.E.	600	DBL. ARM.
500	210	G.E.	250	MCF
400	1150	REL.	250	T-1970
400	300/900	G.M. (2)	250	D4D
300	575/1150	West.	250	CB-500
200	700	West.	250	SK-201
150	280/1000	G.E.	250	MCF
150	1150	G.E. (2)	250	RC-37
150	400/530	West.	250	SK-201
100	400/800	G.E.	250	MPC-6
100	575	G.E.	250	CD-147

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Write for current complete stock lists on electrical power equipment you need or send your list of surplus and used equipment for our offer.

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CHICAGO Electric Co.

1320 W. CERMAK ROAD • CHICAGO 8, ILL.

Circle 522 on Reader Service Card

4 UNUSED CONDENSING 1250 KW WESTINGHOUSE TURBO GENERATORS

TURBINE: 540 lbs. and 850°T.T. working pressure. 8050 R.P.M.

GENERATOR: 1250 KW 440/3/60—0.80 power factor. 1200 R.P.M. with direct connected exciter. Steam rate about 12 pounds per KW hour.

UNITS SUITABLE TO PRODUCE 1500 KW WITHOUT ALTERATION.

ALSO AVAILABLE:

We also have available the following equipment for the above units: 3200 sq. ft. condensers—3200 G.P.M. auxiliary circulating pumps and the condensate pumps.

Send us your inquiries

THE BOSTON METALS CO.

313 E. Baltimore St., Baltimore 2, Md.

ELGIN 5-5050 LEXINGTON 9-1900

Circle 523 on Reader Service Card

38 Years Dependable Service

SLIP RING MOTORS 3 Ph., 60 Cy.

H.P.	Volts	Make	Speed
800	4000/2300	G.E.	600
450	4000/2300	G.E.	1200
400	2200/440	G.E.	600
400	4000/2300	Whse.	720
250	440/220	G.E.	1800
300	4000/2300	G.E.	720
800	440	Whse.	3600
250	4000/2300	Al. Ch.	600
200	2300	G.E.	600
200	2300/440	G.E.	720
150	440/220	G.E.	1800
150	2300/440	Whse.	720
125	2300	G.E.	600

AC GENERATORS or SYN MOTORS, 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2300	G.E.	TS	1800
400	2300/440	G.E.	ATI	720
300	2200/440	G.E.	TS	1200
300	440	G.E.	TS	720
150	440/220	Whse.	G	1200

SQUIRREL CAGE MOTORS

500	2300/4000	G.E.	FT	1200
500	2300/4000	Elliott	SC	1800
400	2300	G.E.	FT	3600
400	2300/4000	G.E.	K	1200
350	2300/4000	G.E.	BEDP	3600
350	2300/4000	G.E.	K	600
300(2)	2300	G.E.	FT	3600
300	2300/4000	L. Allis	FS	1800
300	2300/400	G.E.	KT	600
250	2300/4000	G.E.	K	720
250	2300/440	G.E.	K	1200
200(2)	440	G.E.	Dr-Pf.	720
200	2200	G.E.	KT	1800
200	2300	Cont.	TEFC	3600
150	440	El. Mchy.	Dr-Pf.	900
150	440	Whse.	X-pf.	3600
150	440/220	G.E.	TEFC	720
150	2200/440	G.E.	TEFC	3600
125	2300/440	G.E.	FT	1200
100	440	Whse.	TEFC	3600
100	440	Cont.	X-pf.	1800
100	2200	G.E.	FT	900

CIRCUIT BREAKERS, 3 Pole

2—1600 Amp., G.E., AL-50, 600 V., Air
1—1600 Amp., G.E., AL-50, 600 V., outdoor
1—1200 Amp., Whse., F-134, 7.5 KV., manual
1— 600 Amp., G.E., 15 KV, Sol. oper.
1— 600 Amp., Whse., 7.5 KV, outdoor, New.

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
140	230	G.E.	CD	850
100	230	Rel.	1050T	300/1100
90	230	G.E.	CD	1750

MOTOR GENERATOR SETS

KW	Make	Input., AC	Meter Type	Output V., DC
300	Whse.	4150/400	Syn.	250/125
150	G.E.	440/220	Syn.	250
125	G.E.	440/220	Sq. Ca.	125
100	G.E.	2200/440	Syn.	250
65	G.E. B	2200/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

3—500 kva, G.E., 13,800—240/480 V.
3—200 kva, Mol., 13,800—2300 V.
3—333 kva, G.E., 13,800—2400 V.
3—333 kva, G.E., 2400—240/120 V.
3—333 kva, Whse., 2400/4160Y—240/480 V.
1—300 kva, Whse., 4160—480 V., Dry, New
3—250 kva, Whse., 2400/4160Y—240/480 V.
3—240 kva, G.E., 460—230 V., 3 ph. Dry
3—200 kva, G.E., 2400—460V. Pyr.
3—200 kva, G.E., 13,800—480 V.
3—167 kva, Whse., 4156—480 V.
3—150 kva, Al. Ch., 2400—220 V.
3—150 kva, G.E., 13,200—2300 V.
1—150 kva, Whse., 4160—120/208Y V., 3 ph. Dry
3—150 kva, G.E., 460—230 V., 3 ph. Dry
3—100 kva, Whse., 2400—240/480 V., Dry
3—100 kva, G.E. 2400—120/240 V., Pyr.

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TRANSFORMERS

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MANUFACTURED

Ask for our Stock List

For Sale

3—2500 KVA G-E 69000—2400/4160Y
3—2500 KVA G-E 69000—7200/12470Y
3—1500 KVA G-E 6900—2400/4160Y
3—1500 KVA G-E 69000—7200/12470Y
3—1000 KVA G-E 34500—7200/12470Y
3— 833 KVA W-H 43800—480
3— 667 KVA G-E 13200—2400/4160Y
3— 500 KVA A-Ch. 2400/4160Y—240x480
3— 500 KVA A-Ch. 7200/12470Y—240x480

THE ELECTRIC SERVICE CO., 5322 Hetzel St., Cincinnati 27, Ohio
"America's Exclusive Independent Transformer Service Shop"

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FOR SALE

1—2000 KW G.E. Turbine-Generator 400#-750° F Throttle, Automatic 150# and 85# Extraction, 10# Exhaust. Generator is 2500 KVA, 3-60-480 Volt, with exciter and accessories.

1—135 HP Titusville Boiler 15# W. P. 4485 Lbs. per hour, 1072 square feet of heating surface 212° feed water. Oil Burner and Controls, Excellent condition $2000.00

WANTED

2500-5000 KW Turbine-Generators 400-600# Throttle, condensing or non-condensing.

Write to: **JOLIET EQUIPMENT CORPORATION**
Box 1078, Gross Street, Joliet, Illinois
or Phone: Joliet SA 7-4738 Chicago BI 2-2458

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DIESEL ENGINE

1 HEAVY DUTY NORDBERG

Type TSM—model 32118—1700 HP @ 180 RPM — 21½" x 29". Unit complete with all pumps and coolers. Can be used for generator drive, producing 2400 HP @ 225 RPM. Equal to new. Presently in Maritime Academy.

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ELGIN 5-5050 — LEXINGTON 9-1900

Circle 527 on Reader Service Card

5—435 Hp Comb. Eng. water-tube boilers, 300 psi, gas or oil.
1—G.E. 1500 KVA unit substation, 13200—480 V.
3—Worthington 3500 CFM air compressors, 24x15, #LTC-4, 500 HP gas drive.
1—Chicago-Pneu. 3060 CFM air comp., #19-32-30-18x24, 60 PSI, steam drive.
3—G.E. 1000 KVA transformers, 1Ø, 13800-V.
2—200 HP water-tube boilers, 160 PSI.
1—Gardner-Denver air comp., 445 CPM

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POplar 3-3505

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BABCOCK & WILCOX COAL PULVERIZERS

2—NEW UNUSED Babcock & Wilcox coal pulverizers, Type E-56, each equipped with American Blower Corporation air fan, 15,000 cfm capacity with motor drive. These are complete coal pulverizer installations with blower air fans, attached and unattached structural parts, capacity 20,000# coal per hour each pulverizer. Exceptional bargain.

UTILITIES MACHINERY CORPORATION
1965 East Sixth Street, Cleveland 14, O.

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SKINNER VERTICAL UNIFLOW

250 KVA, 480 volt, 3 phase, 60 cycle Skinner, 2 cylinder vertical used universal uniflow generating unit, steam pressure 150 to 175 pounds throttle pressure, 2 to 5 pounds back pressure.

Available for Immediate Shipment
From Original Foundations in Illinois.

FRANK M. BEESON ENGINEERING CO.
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RE 5-9820

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11—125KVA NAT GAS UNITS 3/60/2400 ▲

1400 HP RATHBUN-JONES 8 Cyls. 18½ x 24 300 RPM

ELEC.-MACHY. CO. STEEL FRAME GEN. 80% PF 20KW BB-DP EXCITERS, 125V. 1450 RPM BELT DR.

G.E. SWITCHGEAR, STEEL CUBICLES, (2) 26" x 65" x 98" High with 600A. Air Breaker, AM-5-150MVA, Elec. Oper. 125V. DC, Draw-Out GDA-33 VOLTAGE REGULATOR, POT., CT's & IAC Relays

ON ORIGINAL FOUNDATIONS AT $10,000.00 EACH
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SAMUEL M. DAVIS

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Circle 531 on Reader Service Card

DIESEL GENERATOR SETS—3 ph., 60 cy.

QTY	KVA	MAKE	VOLTS	RPM	YEAR
2	1000	Hamilton	2300	600	1945
3	1250	G.M.	2300	720	1945
3	250	G.M.	220/440	1200	Rebuilt '60
1	375	G.M.	220/440	1200	1945
1	412	Worth.	240	600	1949
1	150	Superior	240	1200	98% New
1	150	F.M.	2300	300	1940
1	37.5	Buda	240	1200	98% New
1	31.5	Cummins	240	1200	98% New

STEAM TURBO GENERATORS—Non-Cond.

KW	MAKE	VOLTS	STEAM	EXHAUST	YEAR
5000	G.E.	2400/4160	825#	265/20	1954
3000	G.E.	2300	200#	15	1923
3500	G.E.	2300	250#	20	1955
1000	G.E.	2300	400#	90/125	1945
1000	Elliott	480	325#	145/20	1950
750	G.E.	480/4800	165#	15	Late
300	Allis	2300	175#	3/20	Late
250	Allis	240	140#	6/20	1948
125	Allis	240	140#	6/20	1948

STEAM TURBO GENERATORS—Condensing EXTR.

KW	MAKE	VOLTS	STEAM	LB.	YEAR
5000	G.E.	2400/4160	825#	265	1954
3000	G.E.	2300/4000	250#	15	1937
3500	G.E.	4800	825#	265	1954
3000(2)	G.E.	2300/4160	400#	—	1940
1000(2)	Elliott	480	155#	—	1948
750	West.	480	175#	15	1940
600(2)	G.E.	600	150#	10	1930
400(2)	Elliott	480	175#	—	1956
200	Worth.	480	200#	50	1947

PACKAGE BOILERS

Q	HP	MAKE	W.P.	FIRING	YEAR
4	500	Cl. Bk.	200	Oil	1942
1	200	Erie	160	#6	1951
1	150	Cyclotherm	150	#6	1947
1	150	Cl. Bk	15	#6	1956
1	70	Ames	15	#2	1951

AIR COMPRESSORS

CFM	PSI	MAKE	TYPE	H.P.	VOLTAGE	RPM	YEAR
7550(3)	24/20	I.R.	XHE	600	3/60/4160	300	1945
4000	125	I.R.	PRE	700	3/60/3400	164	1946
1853	125	Worth.	DC-2	300	3/60/2300	277	1946
2000(2)	100	Fuller	Rot.	300	3/60/2300	600	1942
676(2)	125	C.P.	OCE	125	3/60/480	277	—
515(4)	125	I.R.	40	100	3/60/440	870	1940/50
494	125	I.R.	XRB	75	3/60	277	—
464	100	I.R.	ES-1	75	3/60	300	1950
368	100	I.R.	ER-1	60	3/60	277	Late

"Everything from a Pulley to a Powerhouse"

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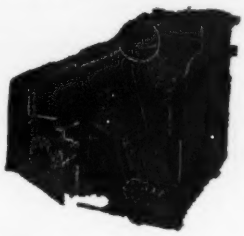
BOILERS NEW UNASSEMBLED



# Steam/hr.	Key	PSI	Temp.
122,500	DF	565	850
121,650	DF	565	850
60,000	SF	435	750
74,000	H	280	500
55,000	A	240	—

DF Double Furnace, SF Single Furnace (illustrated), bent water tube boilers w/economizers and superheaters, B & W's and Foster Wheelers.

H Header type, straight tube, B & W.

A 3 drum, single furnace, Wickes.

Pelnik-Loconti Industrial Supply, Inc.

315 Oriskany St., Yorkville, N.Y.

Utica, N. Y. Ph. RE 6-4621, RE 2-4513

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BOILERS

From the unfinished Battle Cruiser "Hawaii"

Material installed completely and never used.

7 Babcock & Wilcox Watertube Boilers

Approximately 157,000 lbs/hour. Working pressure 600#—850° T.T.—Oil-fired—with all boiler trim. Units are complete with fuel oil burning equipment—feed water pumps—feed water heaters, etc. Units are in prime condition.

CAN BE LOADED AS A UNIT OR DISMANTLED AND SHIPPED IN SMALLER SECTIONS

THE BOSTON METALS CO.

313 E. Baltimore St., Baltimore 2, Md.

ELGIN 5-5050 — LEXINGTON 9-1900

Circle 536 on Reader Service Card

TRANSFORMERS—60 CYCLE

QU.	KVA	MAKE	TYPE	PHASE	VOLTAGE
2	3000	Moloney	TCR	3	7200-4160/2400
2	3000	G.E.	OA-T	3	26,400-4160/2400
1	1500	West.	O.I.S.C.	3	26,400-480 taps-hi
2	1000	Mol.		3	13800-4000/2300
3	500	G.E.	K.S.T.Q.	1	4150-2406
1	300	Penna.	OA Askarel	3	12,470Y/7200-240
3	200	Amer.	C.C.	1	4160/7200-240/480
3	200	G.E.	HS-W2S	1	2400/4160-240/480
3	75	G.E.	H-form KF1		2400/4160Y-120/240
1	75	West.	DS Dry	3	480/240-240/120
3	50	Niagara	Dry-air	1	2400/4160Y-120/240
3	50	Harrison	Dry-air	1	2400/4160Y-220/440

MOTOR GEN. SETS

QU.	KW	MAKE	SPEED	D.C.	A.C.
1	1000	West.	720	600	2300/4160 S.R.
1	400	West.	900	250	3 unit 4160 V. syn.
1	300	G.E.	1200	250	2300/4160 syn.
1	300	Al. Ch.	1200	125/250	3 unit 440 syn.
1	175	West.	1200	125	4160 syn.
1	100	West.	900	230	4160 syn.
1	45	G.E.	1170	30	440V Sq. Cage
2	30	G.E.	1760	230	440V Sq. Cage

D.C. MOTORS—230 VOLT

QU.	HP	MAKE	SPEED	TYPE
1	350	G.E.	1200	ped. type
1	90	G.E.	1750	CDM
1	30	West.	1750	SK-113
1	30	G.E.	2200	CD-85
1	15	Crocker Wh.	1750	CCM, TEFC

SLIP RING MOTORS

QU.	HP	MAKE	SPEED	TYPE	VOLTS
1	500	G.E.	450	MT-422Y	2300
1	450	West.	1800	CW 4-30-9	220
1	350	West.	1800	CW	2300
1	200	West.	585	CW	440
3	150	Al. Ch.	1760	AY-RW	2300
3	150	G.E.	590	1-16	4000
1	100	West.	1770	TEFC B.B.	220/440
1	75	West.	1160	CW 607	220/440
1	75	West.	600	CW 774C	220
1	50	G.E.	870	MT 552	220/440

SQUIRREL CAGE MOTORS—3 phase—60 cyc.

QU.	HP	MAKE	SPEED	TYPE	VOLTS
1	300	Al. Ch.	1200	TRW	2300
1	300	G.E.	1800	6336S B.B. Drip	4160/2400
1	275	G.E.	1180	KT 559BS	2300
1	75	G.E.	1790	KTEFC B.B.	2300
1	75	Cont.	1780	K 6325-S XP B.B.	440
2	100	Cont.	3570	NP 585-S XP B.B.	440
2	250	G.E.	3565	NP5058X XP B.B.	440
2	150	G.E.	875	KT 552Y	440
1	50	G.E.	3530	KF 405Y Vert.	220/440
1	50	Cont.	3520	NP 445X XP B.B.	220/440

MOTORS—SYNCHRONOUS 3 ph, 60 cyc.

HP	SPEED	MAKE	TYPE	VOLTS
325	900	West.		2300
400	450	West.	HR	440
300	720	El. Mh. TEFC		2300
200/100	720/360	West.		4150
150	3600	G.E.	TS 954Y drip	2300
150	1800	G.E.	TS	220/440
150	900	West.		220/440
125	900	G.E.	TS 7536	2300
125	600	G.E.	TS 7641	2300
75	1200	Cr. Wh.	ALT B.B.	220/440

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PHONE NEW JERSEY—UNION 5-2600

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TURBO-GENERATORS • DIESELS

PUMPS • FANS • BURNERS • HEATERS

Large Selection . . . New and Used

EXPERIENCED ENGINEERS TO ASSIST YOU

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WABASH POWER EQUIPMENT CO.

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3300 W. Patterson Ave. Chicago 45, Ill.

Circle 534 on Reader Service Card

LIQUIDATION SALE

Former Universal-Rundle Plant

MILWAUKEE, WISC.

AIR COMPRESSORS

INGERSOLL-RAND Imperial 10, 100 HP 220 V—375 CFM

SULLIVAN—Class WN4—20x12x14—450 HP 220 V—2360 CFM

BOILERS

CLEAVER BROOKS—Gas & Oil—Package—200 HP

KEWAUNEE Type "C"—Gas & Oil—30 HP

CRANES—BRIDGE

1—MILWAUKEE—3-ton—Span 27'—220-V DC

1—MILWAUKEE—5-ton—Span 26'

1—P & H Charging, Monorail Type—1-ton—220V DC

1—P & H—3-ton—Span 24'—220-V DC

3—P & H—5-ton—Span 26'

4—P & H—5-ton—Span 36'—230-V DC

1—P & H—15-ton—Span 80'—220-V DC—190' Runway

M.G. Sets

G. E.—50 KW—220-V DC—75 HP—220-V AC

E. M.—100 KW—250-V DC—150 HP—220-V AC

TRANSFORMERS

3—ALLIS-CHALMERS—750 KVA—13,200 220 V—3 Ph.—60 Cy.

AAA-MACHINERY & EQUIPMENT

Box 4748, Milwaukee 15, Wisc. Phone EV 4-6650

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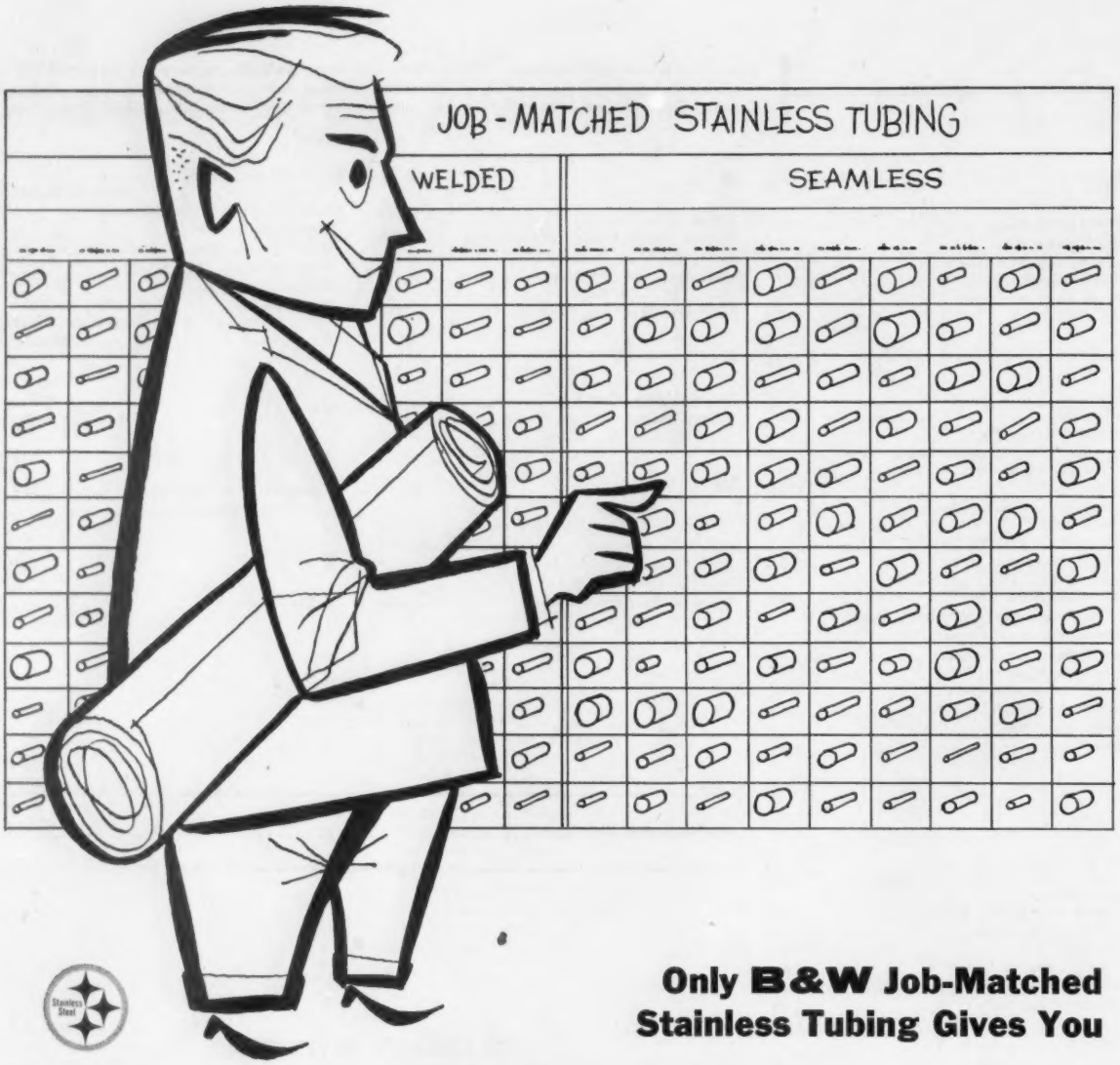

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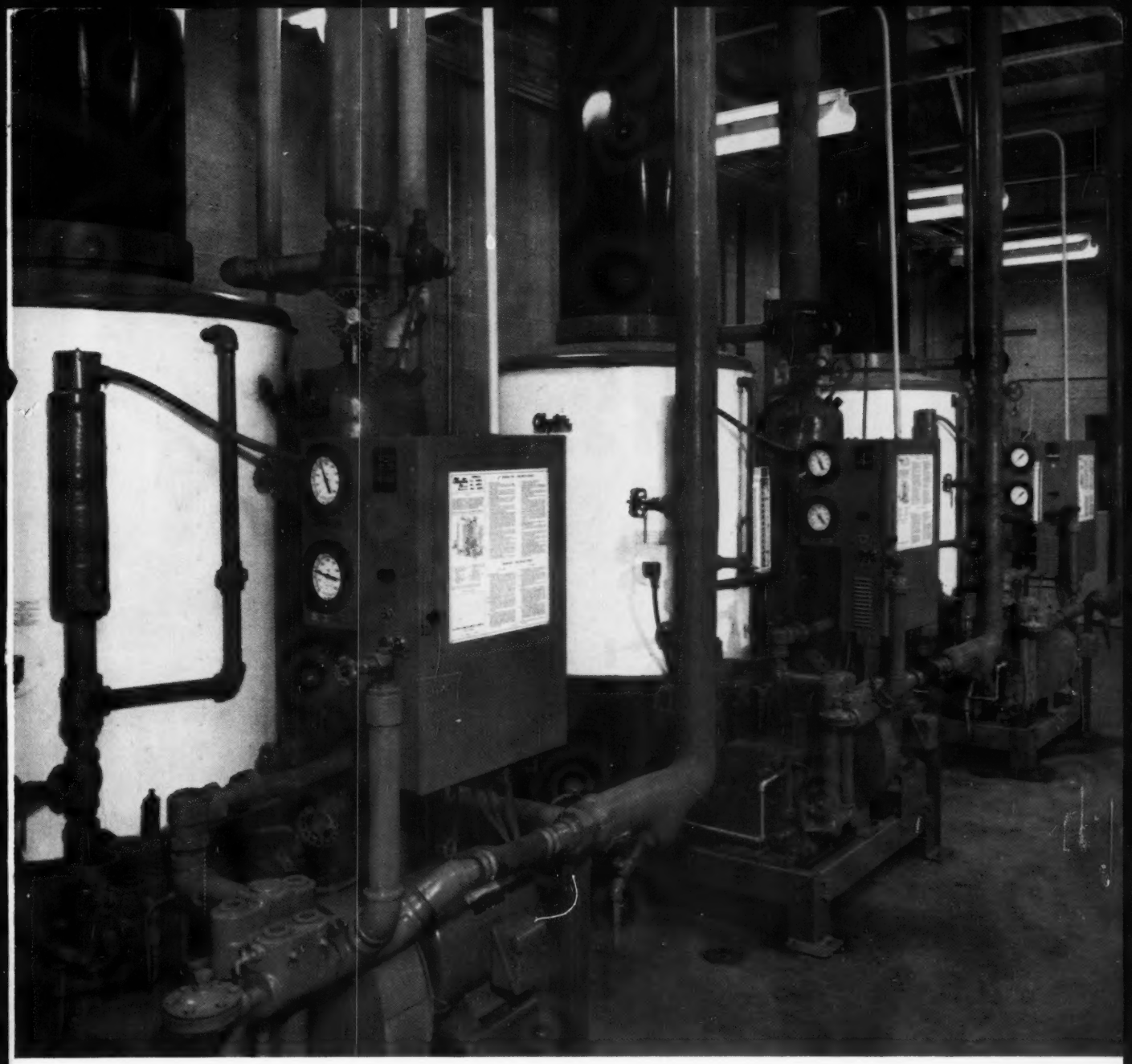

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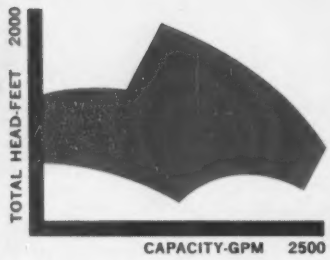
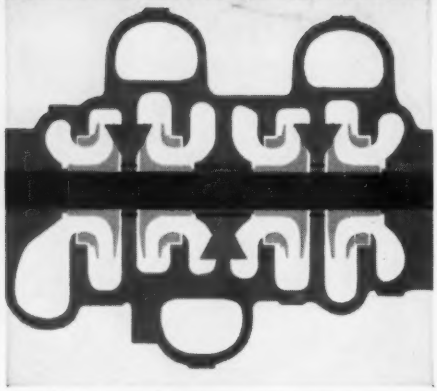
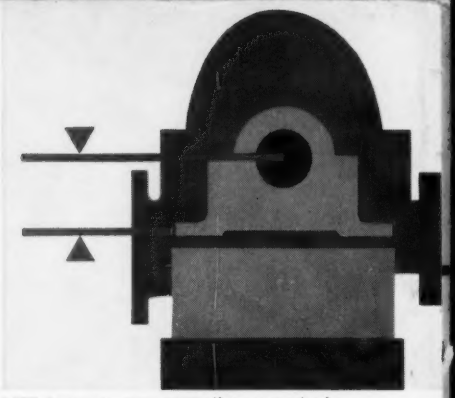


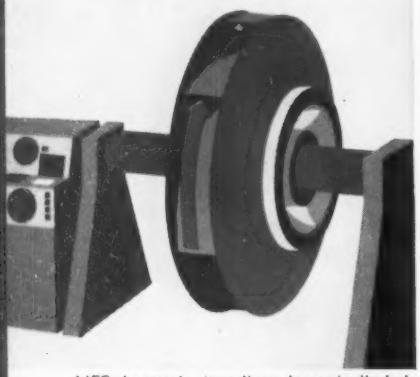
PERFORMANCE. Broad practical range of pressures and capacities handle many jobs.



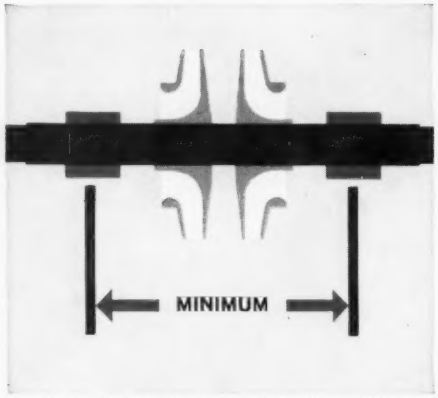
LIFE. Longest because there is only one stage pressure differential across joint.



LIFE. Longest—near-centerline support minimizes temperature effects on alignment.

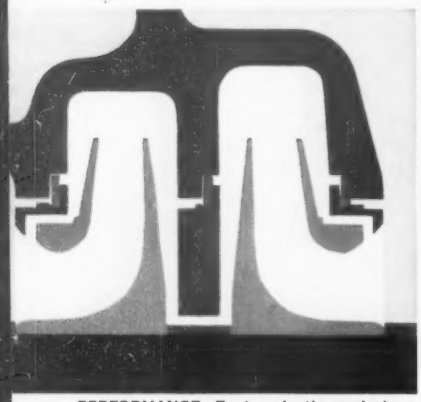


LIFE. Longest—impellers dynamically balanced to prolong seal and bearing life.

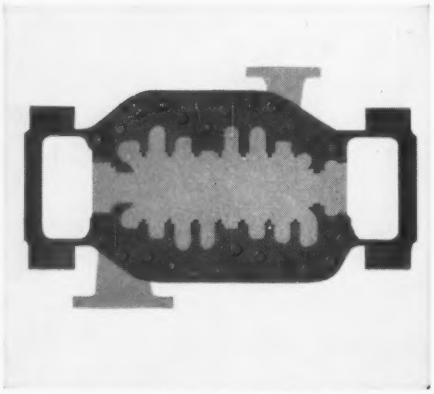


LIFE. Longest because shortest possible shaft spans minimize damaging deflection.

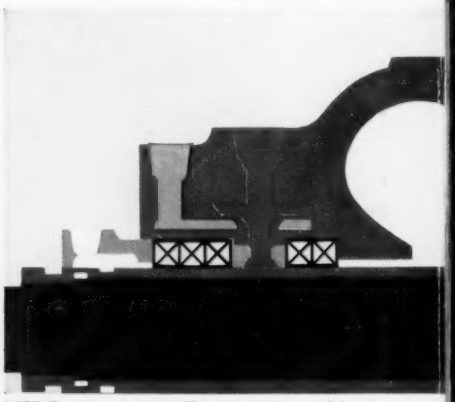
PERFORMANCE. Best because your pump is carefully tested to its design point.



PERFORMANCE. Best—elastic seal rings positively stop interstage leaks and erosion.



LIFE. Longest—close bolting and small diameter casings prevent interstage leakage.



LIFE. Best because stuffing boxes (or seals) can be water jacketed when required.

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